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# Indianapolis Flood Protection

*SYNOPSIS—About 4½ miles of levee is being built along the White River, through the city. The water slope is faced with concrete, and concrete retaining walls are required at some points. Wood forms and two styles of steel forms are used for the walls. The several plants for earthwork and concreting are described.*

The disastrous effects of the 1913 flood in the White River at Indianapolis, Ind., coming as a climax to the results of previous floods, led to a thorough investigation of the situation and the adoption of plans for a costly system of river improvement and flood protection. The work now in progress consists of the construction of a levee for about 4½ mi. along the west bank of the river, extending from 14th St. at Belmont Ave. (above the Emrichsville dam) to the embankment of the Indianapolis Belt R. R. just north of Raymond St.

This is shown in Fig. 1, and it will be seen that the work includes some rectification of the river channel. Plans are being prepared for similar protection to be built along the east bank. Somewhat similar work along Fall Creek, in Indianapolis, was described in *Engineering News*, Dec. 3, 1914.

The levee provides for a considerable increase in width of the river channel at high water, and several bridges will have to be lengthened to give the required waterway. The levee will be incorporated in the boulevard system of the city and will be topped by a broad driveway, with lawn spaces on each side. The top is from 12 to 17 ft. above the original ground level and 4 ft. above the 1913 high-water line. Retaining walls are required at some points, and at the crossing of a group of railways the driveway is depressed through a subway.

A considerable amount of land had to be purchased, and money paid also for damages to abutting property due to its being left below grade by the elevation of street approaches. It will be noticed that just south of Morris St. the levee passes on the outside of a packing company's property. This company did not care to assume any of the expense incidental to changes in its plant.

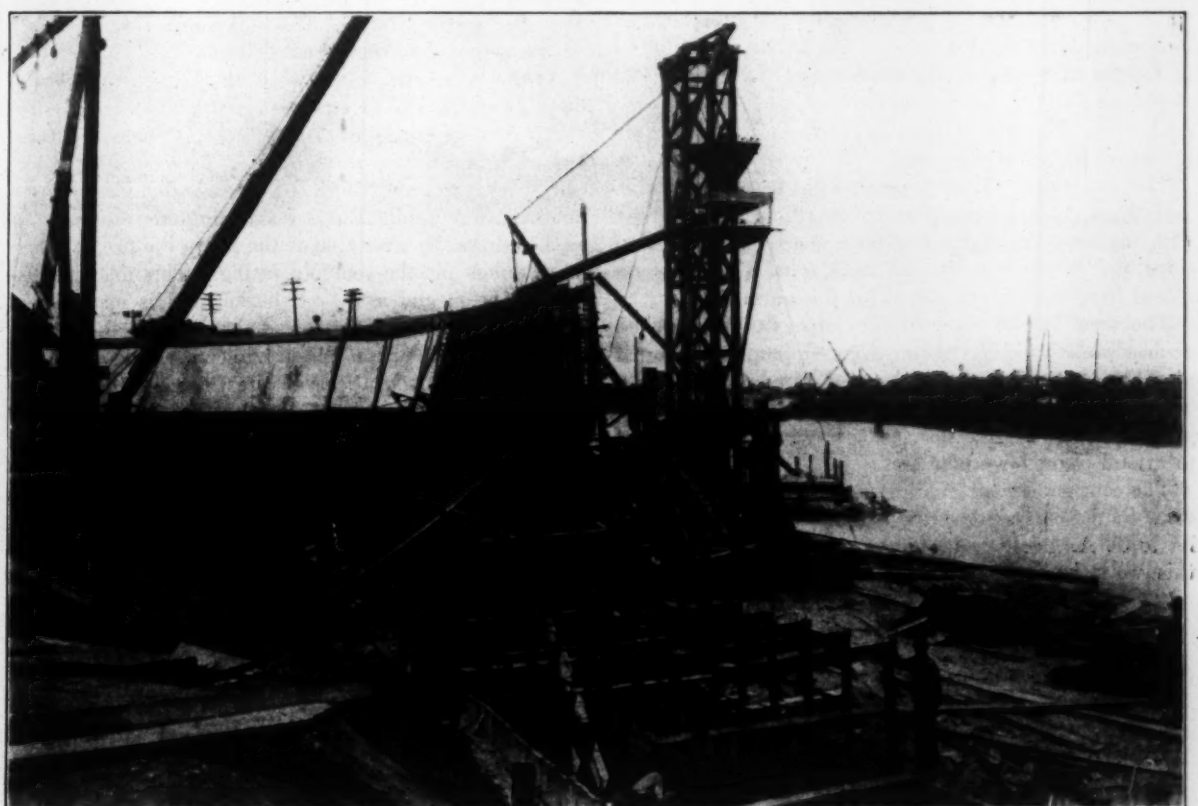


FIG. 1. BUILDING THE CONCRETE RIVER WALL ABOVE THE WASHINGTON ST. BRIDGE AT INDIANAPOLIS.

The curved end at the left runs into the fill for the levee. The steel forms are shown erected and partly erected. On the river bank is the traveling concreting plant, with a spout to the forms

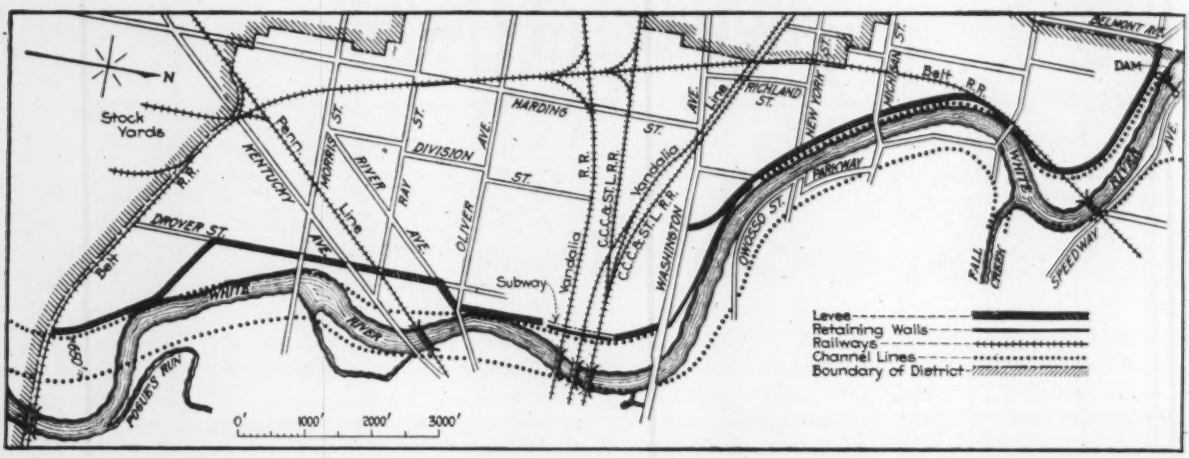



FIG. 2. MAP OF FLOOD-PROTECTION WORK ALONG THE WHITE RIVER THROUGH INDIANAPOLIS, IND.

The work was begun in June, 1915, and the contract calls for its completion by December, 1915. It is under the direction of B. J. T. Jeup, City Engineer, and D. C. Hayne, Assistant City Engineer. The general contract was let to the Marsch, Cleary-White Co., of Chicago, which has sublet some parts of the work as noted later. H. B. Mitchell is Resident Engineer for the company, and W. L. Taylor is Superintendent. The contract covers about 500,000 cu.yd. of fill and 50,000 cu.yd. of concrete. The contract price was not far from $460,000, and the land cost around $655,000.

### Description of the Levee Construction

The typical section of the levee may be seen in Fig. 2, which shows also the special section at the subway. The top width is 75 ft. at the upper end of the work and 60 ft. for the part south of the Washington St. bridge. The slopes are 1 on 2½ for the river side and 1 on 1½ for the land side. The water slope is paved with concrete for the entire length of the work.

The roadway is to be finished with 12 in. of gravel, well rolled, and at some future time this will be covered with macadam paving. The lawn spaces and the land slope will be covered with 12 in. of soil, which was removed from the site and stored for this purpose.

The area for the base of the levee was cleared and grubbed, all buildings were removed, and the ground plowed deeply to insure a thorough bond with the fill. The material for the levee was all excavated from the low ground along its river side, no borrow pit being allowed to extend below low-water level.

The contract for all grading from the north end of the work to Washington St. (about 300,000 cu.yd.) has been let to T. A. Kearns, of Chicago. For the main part of this work he is using a 250-ton Lidgerwood dragline excavator with a 100-ft. boom and 4½-yd. bucket. This machine is mounted on four four-wheeled trucks traveling on two tracks. The tracks are built in sections, with longitudinal timbers under the ties. The machinery is all operated by electric motors using city power, a group of transformers being mounted on a wagon that stands a little distance from the excavator.

This excavator built the levee in two operations. It traveled first along the river bank near the toe of the slope, throwing up the main portion of the fill. It then ran along the top of the fill, taking material from the slope on the river side and casting it over to the land side. The material is nearly all gravel, and this wet gravel dumped from a height makes a very compact fill. The specifications require 10% allowance for shrinkage, but the actual shrinkage is much less.

At the lower end of the work on the Kearns contract there is also a 70-ton steam shovel, loading 4-yd. side-dump cars on tracks of 3½-ft. gage. There are three 10-car trains, with three dinkey locomotives, and a spreader car to level the fill. There are about three miles of track. A small Lidgerwood dragline excavator is used to dress the river side of the fill to the proper slope, in readiness for the concrete facing. This machine has a 75-ft. boom and a 1½-yd. bucket and is operated by steam. It runs along the top of the fill.

The work below the Washington St. bridge is being done by the Marsch, Cleary-White Co. Near the bridge it has used a 70-ton steam shovel served by three trains of 4-yd. 4-wheel side-dump cars of 3½-ft. gage, as shown in Fig. 4. Part of the fill made in this way is along the old levee and behind the concrete walls for the subway. Drag scrapers and teams are employed to spread and level the material dumped from the cars. About three miles of track are required, with 60-lb. rails on wood ties.

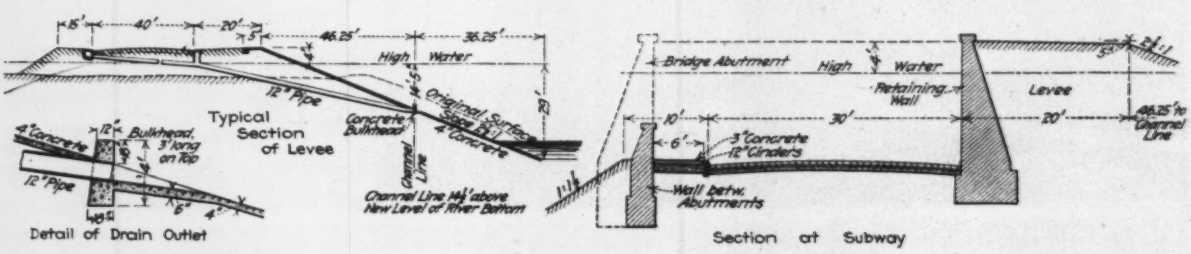



FIG. 3. SECTIONS OF WHITE RIVER LEVEE AT INDIANAPOLIS (RIVER SLOPE FACED WITH CONCRETE)

At the lower end of the work this company has a Monighan dragline excavator, which travels on rollers on a plank runway. This has a 75-ft. boom with 1½-yd. bucket. For a shorter reach, a section of the boom can be removed, making it 60 ft. long, and it can then handle a 2½-yd. bucket. This dragline machine makes the entire fill from the lower level instead of being placed on top of the fill for the finishing work, as on the other contract. It runs first along the edge of the cut or borrow pit, and then close to the toe of the finished fill, scraping the face of the fill to the proper line and slope and casting the material in the rear of the first fill.

All grading is carried on day and night, working two 10-hr. shifts. For the night shift acetylene torches are used.

The various street crossings have inclined approaches of 3 to 4% grade to the level of the levee, and for important streets retaining walls are built on the street lines. At less important streets, however, no walls are used and the fill is extended over the adjacent lots by agreement with property owners. The city pays the cost of raising houses to the new grade. The owners themselves have to undertake the work of bringing their property to grade, but they can arrange to have it done by the city at the time the street grade is changed.

FIG. 4. CONCRETING THE SLOPE OF THE WHITE RIVER LEVEE AT INDIANAPOLIS
The coffer-dam is for placing the concrete on the toe of the slope

### Concreting the Water Slope of the Levee

The entire face of the levee on the river side, with a slope of 1 on 2½, will be paved with a 4-in. layer of concrete reinforced by a layer of wire mesh. This work is being done by the Marsch, Cleary-White Co. Most of it is on the new fill, but south of the 10th St. bridge it is partly on the slope of the natural ground, which is at a higher elevation at this point. After the slope has been dressed by the small dragline excavator previously noted, it is trimmed by slip scrapers with mule teams and then finished by hand shovel and tamping to a smooth surface and the exact slope (shown in Fig. 3).

The concrete is laid in strips 15 ft. wide up the slope, being placed in alternate sections, and the sections separated by tar-paper joints. This facing is anchored by a small retaining wall, or curb, at the top (Fig. 1), the reinforcement being bent over into this. There is no anchorage or provision against scour at the toe, as it is expected that the toe of the concrete will be covered by the gravel and silt of the river bed. This work is shown in progress in Fig. 4.

The lower part of the concrete in each section extends from the toe to a few feet above water, leaving a horizontal joint. This is done in order to complete the concrete above water as quickly as possible. For this work a coffer-dam is formed, partly of wood and partly of steel sheeting 14 ft. long, driven by a piledriver scow. The sheeting is held by wales on a row of 18-ft. round piles. This coffer-dam extends over about four to seven sections and is divided by partitions 60 ft. apart. The depth of water in which this work was done varied from 4 to 11 ft. To keep the scow away from the sheeting a horizontal timber was placed through the leads from the deck, with its end resting on the piles. A 2,000-lb. drop-hammer was used.

The water was pumped out by 6-in. centrifugal pumps, supplied with steam from two portable boilers placed on platforms at the foot of the slope. At one point the coffer-dam was built of sandbags instead of piling, as the water was shallow, and this saved the time of driving piles.

The concrete is a 1:2:4 mix, using screened gravel. The wire netting is laid on the face of the slope, and the concrete is then delivered in place by means of steel chutes laid down the slope. For this work there are three gasoline and three steam concrete mixers, of portable size, making 6-ft. batches. These discharge the concrete directly into the chutes, where the men spade it along. It is made sufficiently stiff to stay on the slope. The surface is finished by means of a wooden float.

At intervals of about 350 ft. are concrete outlets for 12-in. pipe drains from the roadway.

At Washington St., the levee swings inland and its surface is inclined so as to bring the roadway level with the street at the intersection. The water front here, therefore, consists of a concrete retaining wall extending for

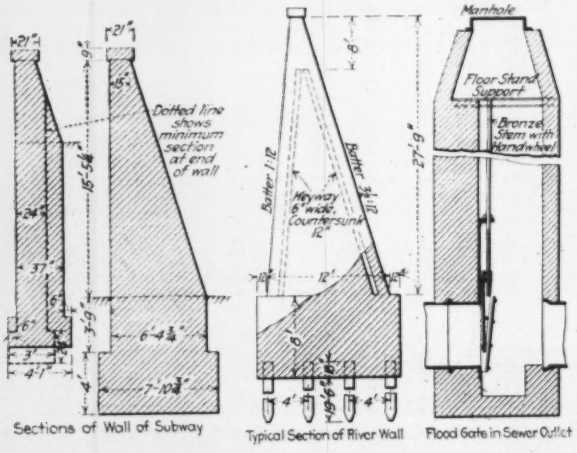

Dotted line shows minimum section at end of wall
Batter 1:12
Batter 3:12
Keyway 6" wide, Countersunk 12"
Manhole
Floor Stand Support
Bronze Stem with Handwheel
Sections of Wall of Subway
Typical Section of River Wall
Flood Gate in Sewer Outlet

FIG. 5. SECTIONS OF CONCRETE WALLS ON THE WHITE RIVER LEVEE, AND SEWER MANHOLE WITH FLOOD GATE

The two sections at the left are for the wall at the subway, the dotted line showing the minimum section (where wall is covered on both sides). The section at the left is the typical river-front wall. At the right is a special manhole on sewer outlet with flood gate

a length of about 2,300 ft. and forming the wing walls of the new arch bridge. The typical section is shown at the right in Fig. 5. This wall is built on timber piling and will contain about 27,000 cu.yd. of concrete. The subcontractor for the wall is the Kuert Contracting Co., of Indianapolis.

This wall is built in steel forms of the Hydraulic Pressed Steel Co.'s make, shown in Fig. 6. These forms consist of a framing of upright and horizontal bars, fitted with clamps to secure panels, which constitute the face of the form. The main vertical pieces are U-shaped, flared at the wall and having slotted keyways in the back. The form boards, or panels, are 36x36 in., of wood, faced and edged with pressed steel. Clamps of U-shape, held to the vertical pieces by bolts or keys fitting into the keyholes, straddle the vertical piece and are driven home by wedges until they are tight against the backs of the form boards. When these boards are to be removed, the wedges are slacked and the clamps are turned parallel to the upright piece. The forms are kept from spreading by rods with Universal clamps, and until filled with concrete they are spaced apart by wooden temporary struts, held tight by the tie rods. Two men with hammers can erect the forms or remove them. For the curved end of the wall, where it joins the levee, wood forms were used. Tarred felt is laid on the back of the wall.

Gravel is excavated from the river by a dragline cableway and delivered to a washing and screening plant from which the sand and gravel fall to the elevated bins. From these bins the material is dumped into small steel cars which are hauled up a short cable incline to discharge into the hopper of a ½-yd. mixer. The concrete, in turn, is discharged into 1-yd. drop-bottom steel cars, of 24-in. gage, which run out on a trestle to deliver the concrete in place. There is also a steam derrick to handle material and to handle a grab bucket for excavation.

The concrete mix for all walls is 1:2½:5, and the use of the natural river-gravel mixture for the aggregate is permitted. This is not allowed for the 1:2:4 concrete for the slope facing. The fine aggregate is specified to range from a ¼-in. screen to a No. 30 sieve. The coarse aggregate is such as will pass a 1½-in. screen and be retained on a ¼-in. screen. The ends of sections of walls are formed with vertical V-shaped keyways 12 in. wide and 4 to 6 in. deep. Concrete surfaces that are to be permanently exposed are rubbed with wood blocks and clear water within 48 hours after the removal of the forms.

### Concrete Gravity Retaining Wall

The new channel line approaches so nearly to the power house of the Indianapolis, Terre Haute & Eastern Electric Ry. at 10th St. that there is not room for the full dimensions of the levee. Here a concrete gravity wall will be built, with backfill behind it and the levee slope in front, the wall being covered for its entire length. This wall will be about 950 ft. long, containing about 19,000 cu.yd. The contractors are Hickey Brothers, of St. Louis, Mo.

The section is similar to that of the river wall, Fig. 5. The base of the wall is practically a rectangular block 5 ft. deep and 8 ft. 3 in. to 14 ft. 10 in. wide. It has pockets in the top to bond with the upper portion, which is built separately. This wall has four rows of timber piles 18 ft. below the base and with 18 in. of their heads embedded in the concrete.

The concreting plant is located near 10th St. The materials are brought in on railway cars. Sand and gravel are dumped from these cars into a track hopper, beneath which is a pit for the bucket of a Galion unloader, operated by a gasoline engine. A man beside the track operates a lever for the hopper gate by which the bucket is filled and another lever for starting and stopping the

FIG. 6. STEEL FORMS WITH FRAMES AND PANELS FOR CONCRETE RIVER WALL

The bottom panels at the right have been removed to show the smooth surface of the concrete

engine. The bucket travels up an incline to the top of the storage bin.

From this bin the materials are fed to a measuring box containing the amount for a batch of concrete. This is at the ground level and has a drop bottom through which the charge is delivered to the steel-lined charging hopper of a Milwaukee 1-yd. mixer operated by an electric motor.

The cement is stored in a shed at the ground level, and the sacks are emptied into the hopper.

The concrete is discharged into a 1-yd. bucket in an elevator tower, which was 60 ft. high for the work on the lower portion of the wall. From this the concrete was spouted directly into place or into small steel side-dump cars, which were hauled by mules to a chute. For the upper section of the wall the tower was made 150 ft. high, so that the spouting could reach the entire length of the work.

For this upper section of the wall Blaw steel forms are used, in lengths of 30 ft. These are suspended from a traveling frame that straddles the walls and forms and can be moved ahead on rollers. Two derricks, with grab buckets, make the excavation for the lower portion of the wall. These, as well as the pumps, are operated by electricity.

Near Maryland St. the levee crosses three railways, which are at the level of the top of the levee. As the grades could not be raised, the roadway of the levee is depressed about 14 ft. to pass under the tracks, as shown in Fig. 3. A concrete wall (Fig. 5) retains that portion of the levee (20 ft. wide on top) on the river side of this depression. Along a part of the land side is a small retaining wall, extending between the bridge abutments and holding the toe of the railway fills.

The river wall contains about 5,000 cu.yd. and was built in wood forms. The 30-ft. roadway is level for about 500 ft. at the depressed level, and has approach grades of 3%. It will be paved with brick on 2 in. of sand and 6 in. of concrete. There will be one 6-ft. sidewalk, having a 3-in. concrete slab on 12 in. of cinders. The work on this subway was done by the Marsch, Cleary-White Co., but the railways built the bridge abutments.

# Selecting Construction Power-Plant System

AN EDITORIAL REVIEW

*SYNOPSIS—A review of the special features and advantages of different forms of power—steam, electricity, gasoline and compressed air—based upon accumulated experience of numerous contractors and engineers engaged on work of various kinds in different sections of the country, as well as from the manufacturers of machinery. It presents a summary of experiences and opinions and does not attempt to make recommendations or form conclusions.*

In purchasing equipment for contracting or other construction work an important consideration is the power to be used. For each job the problem must be dealt with in the light of the conditions affecting that job. Local conditions or features have an important bearing upon the plant and its operation, and may make one form of power or another desirable, quite apart from general considerations. In other cases two or more forms of power may be equally suitable or available, and then the question becomes one of convenience and economy.

The selection will depend to some extent on the location, whether in a city or town or in open country. Other factors to be kept in view are the class of work and the machinery to be used, the character of the labor, the fuel available, the water-supply, the distribution of the construction plant (whether concentrated or scattered), the size of the job, the time it will occupy and the equipment on hand or to be purchased. On construction work the question of fuel consumption may be much less important than reliability and continuous operation of the plant. The cost due to loss of time by an occasional idle crew waiting for repairs to be made is greater than a big saving in cost of fuel. This does not mean that direct waste should be allowed. In fact, an essential for financial success in contracting and for economical construction under any plan—whether by contract or day labor—is the locating and checking of waste and leaks throughout each job.

The forms of power to be considered are steam, gasoline and oil, electricity and compressed air.

Steam power is used so largely and has been employed for so long that the handling of steam-driven machines is well understood. It is natural to expect this power to be held in great favor. Its strong points are its reliability and flexibility, the readiness with which it can be adapted to varying conditions, its ability to stand overloading and hard usage, its successful operation with the smallest and largest machines, the simplicity of making wide speed variations, and the ease of adjustments and repairs. All these are cited by different contractors and engineers as the results of their experience.

Another point in its favor is that it is easy to obtain labor familiar with steam plant, and competent not only to handle it but also to maintain and repair it. In operating such machines as hoists and excavators, experienced men seem to know instinctively just how to apply steam power and how best to work the machine under difficulties. This may not seem important when selecting equipment, but the contractor or the engineer in charge of construction will find it a very important factor in getting the most out of his apparatus.

On the other hand, there are boiler troubles to be expected; the questions of space and weight may enter into consideration; and steam is not adapted for economical distribution from a central boiler plant. The supply of coal to small scattered machines is troublesome and costly, and there is often great waste of fuel at such machines. The fuel consumption, however, may be a relatively unimportant matter. An adequate supply of water, or water of quality suitable for boilers, is occasionally an almost insuperable difficulty. In cities the use of steam may be objectionable, or even prohibitive, on account of the smoke, noise and dirt. Oil, or gasoline and electricity may then be considered.

Electric power has been used with great success for driving such varied machinery as concrete mixers, hoists, pumps, compressors, steam shovels, etc. Some users,

however, consider it less satisfactory than steam for hoists subject to such severe service as those on piledrivers, derricks and locomotive cranes. The torque and overload characteristics of available electric motors range so widely that practically any needs can be met. The motor is not quite so rugged as the steam engine, however, since when it gets stalled there are severe though brief rushes of current which through repetition seriously injure the insulation and reduce the useful life. Electric machinery requires intelligent installation and handling, but some of those who have used various kinds of power are of opinion that under such conditions electricity presents many practical and economic advantages. The power usually is obtained from existing sources of supply, but under special conditions and for very large jobs it may be economical to generate current on the work.

### Electric Power Has Important Advantages

A number of contractors doing work in large cities report that they use electric power whenever possible. At ordinary rates it is usually the cheapest, due largely to the elimination of waste which usually occurs with steam or other fuel. The machinery can be started and stopped without any preliminary "warming-up" or stand-by expenses. This equipment is considered also to be more reliable than gasoline and fully as reliable as steam. There has been little trouble from failures or breakdowns to cause high labor cost and other expenses of having a large gang of men disorganized while repairs are being made. In cities the freedom from smoke, dirt and noise is a special advantage, apart from the question of cost.

The power-supply lines in cities are usually numerous and well protected. In many places they are underground. Under such conditions there is not apt to be a complete interruption to the power supply. Not as much can be said for rural districts, if reliance has to be placed on a single transmission or distribution line.

The use of electricity by no means has been confined to cities, however. Electric shovels (mainly of the smaller class) have been used in a number of cases. On the Mesabi iron range the Great Northern Power Co. has sought to develop a field for the use of its current in operating the excavating shovels, but as yet no large-size electrical shovels suited for this work have been reported. Electrically operated suction dredges have been used in several cases, notably at Pearl Harbor, East St. Louis, Cleveland and Minneapolis (see *Engineering News*, June 13, 1912, p. 1105; Aug. 28, 1913, p. 432; Feb. 4 and May 6, 1915, pp. 220 and 889). All the diversified construction work on the Sun River Project of the United States Reclamation Service is being done by electric equipment. Details of this work were presented in *Engineering News*, Oct. 29, 1914, p. 870. Electric rock drills, of both piston and percussion types, are available (see *Engineering News*, Mar. 5, 1914, p. 499; July 30, 1914, p. 249; Sept. 16, 1915, p. 576). One of the great advantages claimed for both is a 90% reduction in power required for a given job.

### Electric Plant for a Drainage Contract

A construction plant with semipermanent generating station was proposed for a large land-drainage contract, where the work would last for some years and would call for the regular operation of four or five large excavators. The estimates of first cost and daily cost of operation of this plant did not show a saving over individual steam-operated equipment, but it was figured that the daily output would be greater, thus showing a lower cost per cubic yard of material excavated.

For the efficient and economical operation of this electric plant it was proposed to organize the work as follows: (1) A civil engineer as general superintendent, to have charge of the men operating the excavators and to watch the cost per cubic yard; (2) an electrical engineer as assistant superintendent, to have charge of the electrical equipment and transmission lines and of all labor handling this equipment; (3) a mechanical engineer as assistant superintendent, to have charge of all machinery up to the motor and of all labor engaged upon the machinery.

An interesting example of the use of electric current on construction work is afforded by the Lahontan dam of the United States Reclamation Service (*Engineering News*, April 22, 1915), where a water-power generating plant was installed. Coal would have cost $9 per ton delivered, and a large saving was effected by the use of current costing only about 1c. per kw.hr. Besides the large saving in cost, it was found that the cableways, derricks, shovels, excavators, pumps, conveyors and practically all the construction machinery were operated more conveniently. Breakdowns or delays for repairs were rare. There were no banking and starting of fires and no freezing of pipes. The superintendent states that "when the day's work was done, the switch was thrown and everybody walked off the job knowing that the machine would start in the morning when the switch was thrown on."

### Electric Power for City Construction

In many cases power is taken from the trolley wires of street or interurban electric railways; but this is apt to be unsatisfactory because of the great variation in voltage during hours of peak loading or when a number of cars are operating on the line with the machines. This may not be serious for miscellaneous small work done by the railway company's force, but on a large job it is likely to be serious for contractors, some of whom have called attention to this point.

The use of electricity in large cities may also impose special difficulties upon the contractor due to the existence of more than one style of supply. It is stated that in Greater New York, for instance, a contractor wishing to operate his plant by electricity must have several different types of motors on hand. In some sections there is only direct current, but of 220 and 550 volts, while in other districts there is alternating current of three voltages, so that five different motors must be available for each machine. It may be possible to secure convertible direct-current motors and proper transformers, so that only two or three motors would be necessary. In the city the price of current also varies greatly, ranging upward from 1½c. per kw.hr. However, several very favorable replies indicate that this difficulty is not serious.

### Field for Gasoline and Oil Power

Gasoline engines have been used extensively for the operation of construction equipment, but mainly for the smaller class of machines, although dredges, shovels and other excavators may be included in the list. They are considered especially suitable for small scattered jobs, whether in the city or the country. These engines are

constant-speed motors, which is an advantage in some cases and a disadvantage in others.

Starting is difficult compared with steam and electric drive. The engines have to be turned over a few times by hand or auxiliary power, while the machine is lightly loaded, and then the load has to be thrown on more or less gradually by a clutch. Starting is so inconvenient that the engine is not stopped for small idle intervals. This throws a heavy burden on the clutch and increases both the maintenance and delays to work. Some shovels employ a stepped-drum hoist so as to get slow speed and large torque while the dipper is in its bank, but high speed and small torque when free of the bank.

Gasoline power is regarded by many contractors as a necessary auxiliary to steam plant and not a real competitor. There are localities where the cost of fuel and good boiler water or the existence of smoke ordinances makes gasoline the only alternative. There is no possibility of distribution of power, as with steam or electricity.

An objection raised by several contractors who have had experience with the engines is that they are liable to frequent stops and breakdowns, causing loss of valuable time and increasing the labor cost by rendering gangs of men idle until repairs are made. One cause of this seems to be the general idea that any laborer can operate a gasoline engine. Experience indicates that for satisfactory work it requires intelligent handling and regular oversight. If the engine is left to a man who simply starts it and then goes about other work, trouble is liable to occur. Difficulty in getting operators who can remedy defects and make repairs, and the delay and expense in getting repair men from the shops are other objections.

Some contractors consider gasoline engines suitable for light machines, but inadvisable for larger machines, and others are doubtful of them for work where it is important that there should be no interruption and where delays or stoppage would be serious, as in pumping out coffer-dams, etc. On the other hand, it is admitted that their use is increasing, and that greater experience with them (alike by builders, users and operators) will result in more satisfactory service.

For small concrete mixers the gasoline engine is lighter and more convenient than a steam engine and boiler. It also requires less attention. Gasoline road rollers are said to show an economy over steam rollers, due largely to the fact that they can work continuously without stoppages and delays for taking coal and water, raising steam, banking fires, cleaning flues, etc. Comparing a certain gasoline roller and two steam rollers operating in the same service, the daily cost of the first averaged $5.14, against $9 and $10.26 for the others. The cost for fuel, oil and waste averaged $1.14 for the gasoline machine and $1.34 and $2.21 for the steam machines. A high item of expense for the latter was the teaming of coal to the rollers, which averaged $3.69 and $4.07 per day.

Gasoline shovels are considered less speedy and reliable than those operated by steam, while for contractors' locomotives it has been suggested that a cheap but efficient variable-speed transmission is needed to make the machines satisfactory. Reliable and efficient hydraulic transmissions are available, but makers of gasoline engines for contractors' service have kept away from such apparatus. The machinery concern which is brave enough to undertake to apply these—or some simpler devices—to its work, it is reported, should reap a good reward.

Gasoline engines are used extensively in the construction work of the United States Reclamation Service, especially on the smaller jobs in desert country which are so scattered that the distribution of coal would be inconvenient and expensive, while electricity would be out of the question. Until within the past two or three years steam was considered as being the more reliable, and is still used for some of the concrete mixers, which work in a cloud of dust and cement. But for pumps, elevators, hoists, etc., the gasoline engines have been found very satisfactory.

Attention must be given to the fuel. In most cases it is common gasoline, but kerosene and distillate have been used with success. Often the engines are started on higher grade fuel and changed over after a few minutes. In one case "motor spirit" was substituted for gasoline because of its lower cost, but it caused excessive deposits of carbon in the engine, with consequent irregular sparking and combustion and frequent delays of 15 min. or more. The expense due to idle labor was so much greater than the saving in fuel that the best grade of gasoline was used for the remainder of the work. Engines working on distillate have been employed to operate drag-scrapers. Oil engines are successful for stationary plants, pumping engines, etc., but are felt to be generally too heavy for portable plants. Some notable designs of dredges with internal-combustion engines were described in *Engineering News*, Sept. 12, 1912, p. 468, and Jan. 28, 1915, p. 173.

### Compressed Air

The use of compressed-air power is limited usually to special kinds of apparatus, and it is only rarely that it is distributed over a wide area to serve the various machines employed on a construction job. Such a case would be where a large supply of air at suitable pressure was necessary for special work. Considering power distribution alone, air is more efficient than steam, due to the lack of heat losses. The generation of compressed air is of course inefficient. Compressed air is in general use for rock drills, and it has been applied also to hoists, pumps and other machinery. Pumping water from deep wells is one of its most successful applications—both in temporary and permanent plants. The efficiency is rather low, but the investment charges and upkeep are low. On steel bridge and building construction some compressed-air power for riveters, hand hammers, etc., is required, whatever other power there may be—for instance, at the Quebec Bridge (see *Engineering News* of Oct. 14, 1915).

For tunneling, compressed-air drills and shovels are largely used because of the freedom from noxious gases and heat. In recent years systems for mixing and placing concrete behind tunnel forms by compressed-air carrier systems has come into considerable use (see *Engineering News* of Dec. 31, 1914, p. 1296, for work done in New York City, and Jan. 21, 1915, p. 123, for an installation at Montreal).

**The Inflammability of Gasoline** and air mixtures has been recently redetermined by G. A. Burrell and H. T. Boyt, of the United States Bureau of Mines, and their results are reported in Technical Paper 115, just issued. With gasoline having a specific gravity of 73° Bé., the limits between which the gasoline and air mixtures were inflammable were found to be 1.4% and 6.4% of gasoline vapor. When the initial temperature was increased before ignition the low limit was reduced to 1.02%. The range for complete combustion of mixtures was narrow and found to lie between about 1.5% and 2.5% of gasoline.

# Subaqueous Rock Excavation--I

By Charles C. Phelps*

*SYNOPSIS—Review of the development of American practice in excavating rock under water. First of a series. Design, equipment and use of drill barges for nontidal waters.*

In spite of the great advances in 50 years of American practice in subaqueous rock excavation, there has been no single review of its progress or any complete presentation of the methods and apparatus developed. That lack it is hoped to supply in some measure by this and two subsequent articles, for the accumulated experience of one of the largest makers of subaqueous rock-drilling equipment has been made available. Of course there are some matters which might have been better treated had the files of all the manufacturers and contractors been open for use.

## Economics of Subaqueous Work

Of the best-known methods of excavating rock under water—breaking by impact and dredging the débris, drilling and shooting before dredging and simple dredging without previous work—drilling, shooting and dredging is the scheme most extensively employed. Therefore the other procedures will be briefly dismissed here to take up the practices in this line alone, for this work is truly an art in itself.

It appears to be still an open question (according to the General Report of the 12th International Navigation Congress, 1912, "High-Powered Dredgers and Means of Removing Rock Under Water") whether it is more economical in the softer rocks, such as corals, soft limestone, tufas, etc., to build large dredgers of great power to excavate without blasting or to use a lighter and less costly dredger, loosening or breaking the material by the use of explosives. In using powerful machines without blasting there is always great strain and wear on both hull and machinery with consequent depreciation. The question then is whether this depreciation costs more than the drilling or blasting or whether the increased quantities that would be dredged in the same period of time when the material has been broken up by explosives would compensate for the cost of drilling and blasting.

*Ingersoll-Rand Co., 11 Broadway, New York City.

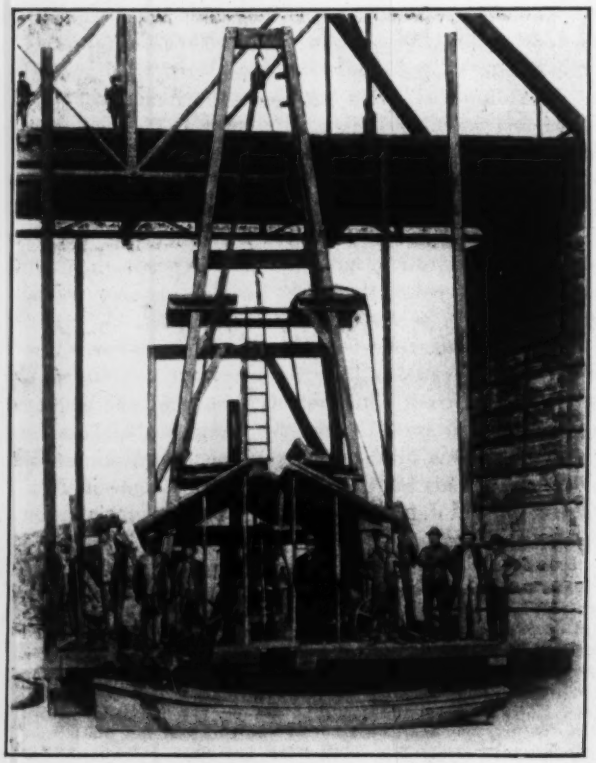


FIG. 1. BARGE WITH CORE DRILL

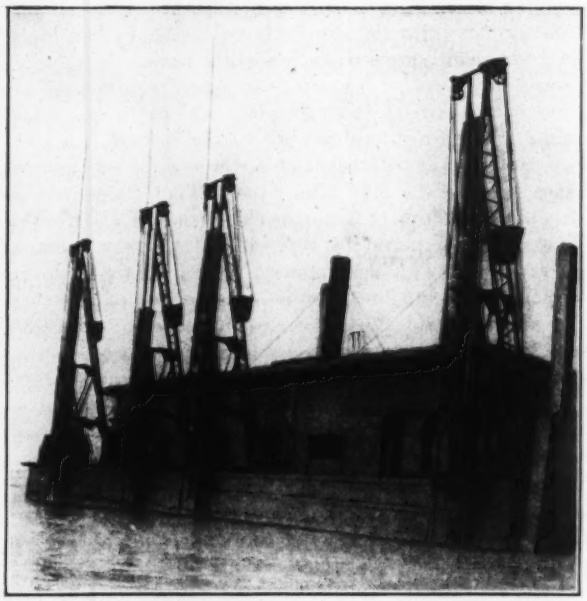


FIG. 2. DRILL BARGE "HURRICANE"

From a great amount of data available (reviewed in the report cited already) it would appear that drilling and blasting by the American method are the most rapid and economical means of preparing the harder rocks for dredging where the depth of rock to be removed is greater than 2 ft. When the rock to be removed is less than 2 ft. in depth the impact breaker attains greater economy as a means of loosening the rock. This depth of 2 ft. may be increased in thinly stratified rock or in rock that shatters easily.

## Early Methods of Excavation

In the early days the usual methods were to lower explosives on the surface of the rock and attempt to fracture it by "surface blasting." The surface blast has very little effect on a ledge, but it can break up boulders and jagged projections of rock in a fairly satisfactory manner. Later a form of drop bar was introduced, by means of which holes were drilled and charges inserted in the regular way. This process was very slow and correspondingly expensive. Still another form consisted of a very heavy cast-iron bar

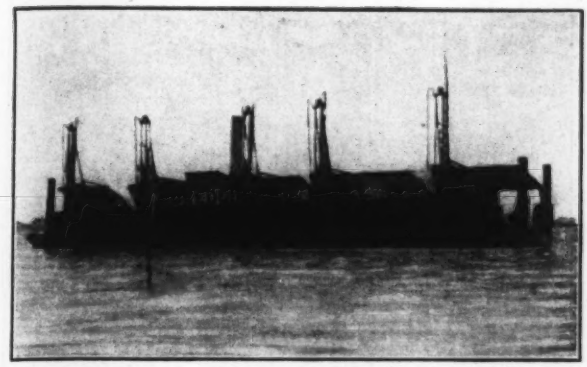


FIG. 3. BUFFALO DREDGING CO.'S "NO. 5"

tipped with a sharp steel point, which was alternately raised and allowed to drop on the rock. The bars used in this method weigh many tons. In operation the sharp point strikes the rock with great force and breaks off a certain amount with each blow. We occasionally hear of this system being used abroad even today, but in America it has been abandoned almost entirely for drilling and shooting.

Diving is scarcely ever necessary nowadays owing to the fact that wherever required both the drilling and charging can be done through submarine tubes, which serve very efficiently as guides. In the early days it was necessary to send a diver down to guide the bit until the hole was started, but through long experience the drill runners have acquired a highly developed "sense of feeling," which, added to the more adequate means now at their disposal, makes it possible to carry on all the operations from above the surface. Improvements in the drilling apparatus and in the methods of controlling it—especially the more recent methods of steam control—have greatly broadened the field of subaqueous excavation and lessened the cost of operations.

There are four distinct methods of subaqueous rock drilling in extensive use today, as follows: (1) From a floating drill barge, equipped with movable towers on which the drills are mounted; (2) from a floating boat equipped with submarine drilling frames, which carry the drills and which can be lowered to the rock bottom; (3) from a platform adjusted so that it can be raised above the wash of the waves, and equipped with tripod drills; (4) from a floating raft or pontoon equipped with tripod drills.

The later developments in submarine-rock excavation may be said to comprise refinements rather than changes of method, the four systems being those in vogue today. Even with such a variety of methods practically every job involves special problems peculiar to itself, so that much ingenuity is frequently demanded of the engineer in charge, as well as the crew.

### Rock Drilling in Nontidal Waters

In studying operations on inland rivers and lakes and in sea harbors where there is little difference in tide levels, it is seen that much of the information to be recorded is equally applicable to other fields.

Before undertaking subaqueous rock excavation it is sometimes necessary to do a certain amount of prospecting to determine the character, order, thickness and extent of materials below the bed of the channel. With such information at hand the contractor is in a better position to figure the probable cost of rock removal and the engineer in charge is better able to plan the work.

The core drill is the most convenient and efficient drill for work of this class, as it extracts a core which is a perfect record of the strata to be penetrated. It has been successfully used for making soundings for bridge, wharf and dam foundations and for channels. Fig. 1 shows a prospecting barge with calyx drill used by the C. B. & Q. R.R.

In inland waters, waves, strong currents and the possibility of floods are occasional difficulties encountered and the likelihood of severe storms, extremely low temperatures, danger from ice packs, and the limitation of working space due to density of navigation are special considerations that might have to be taken into serious consideration in choosing equipment.

The various depths of the water over the area to be excavated and the depth, width and length of the finished channel must also be taken into consideration in planning. Other factors are the nature of the rock bottom, whether it is composed of sandstone, limestone, shale, flint, etc., or a combination of these materials, and its degree of hardness. It has also to be determined whether the rock is homogeneous or stratified, and if the latter, whether the material is solid or loose. The nature of the bottom mud or sand covering is a matter of no small importance.

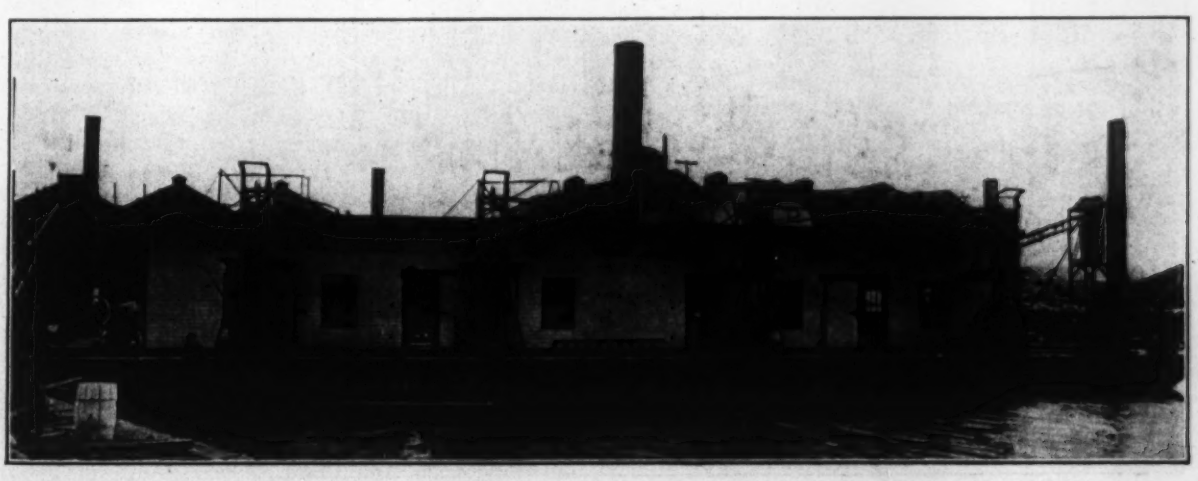


FIG. 4. GOVERNMENT DRILL BARGE FOR MISSISSIPPI RIVER WORK

For work in nontidal waters the drills are mounted on barges of various types, and in designing and using drill boats the direction of the water currents, and even the direction of the prevailing winds, are matters that are too often left out of consideration until experience has taught that it pays to offer the least resistance to these elements.

When the above-mentioned conditions are fully known then the method of drilling, the sizes and lengths of starting and bottoming steel, the kinds of bits, sizes of drilling machines, etc., can be determined, as well as the best means of penetrating the overburden, should there be any.

### Spacing, Depth and Diameters of Drill Holes

The most economical spacing and diameters of the holes depend on a number of factors, such as the hardness of the rock, its stratification and the required depth of the channel, as well as the equipment available on the boat. As a rule it pays to drill large holes and fewer of them, permitting the use of heavy charges. The diameters of the starter bits depend on the depth of hole to be drilled, and for a channel of any depth usually range from 4½ to 6 in.

The most economical spacing and charging may be based largely on the experience of the engineer on the ground, but are best determined by actual trial. It is customary to drill the rock directly to depth rather than to remove it in two or more layers. It is usually necessary, however, to drill the holes a little below grade, to make sure that the dredging will be done to specified depth. In perfectly homogeneous rock the depth below pay grade ought to be about half the distance between holes. In practice, however, the rock is seldom perfectly homogeneous, and therefore this rule usually has to be modified considerably, as it is cheaper to go a little below grade in the beginning than to "sandpaper" the bottom after dredging. The dip of the river bed, stratification of the rock, seams, embedded stones or pebbles, boulders and the grain of the rock, all affect very materially the proper depth.

Many of the most important subaqueous drilling operations in this country have been for improving the waterways of the Great Lakes. This work has required the heaviest of equipment and the present apparatus has been gradually evolved. Formerly only one or two drills were mounted on each barge, and the boats were often but little more than makeshifts—old scows, etc. As the art of submarine drilling progressed, boats particularly adapted to such service were developed, the largest of them having as many as five or six drills.

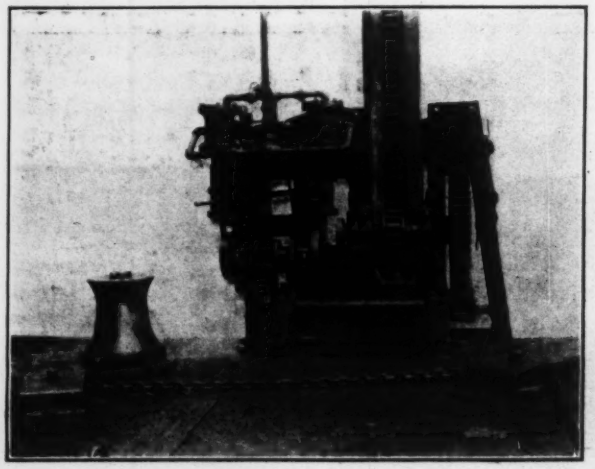


FIG. 5. SPUD HOIST ON "HURRICANE"

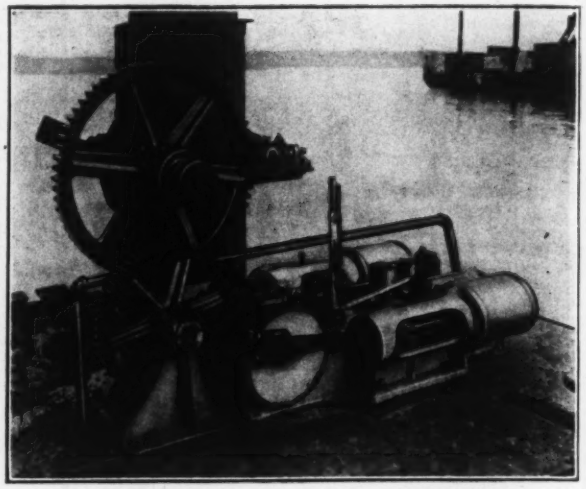


FIG. 6. SPUD HOIST ON MISSISSIPPI BARGE

The drill barge is anchored by four spuds, or mooring posts, of a size that will support a fraction of the weight of the boat and insure it against shifting. The drills are usually mounted on steel or wooden guide towers, secured to one side of the barge. Many of these boats are built almost entirely of steel. While they are made in a great variety of sizes, in recent years they have been more or less standardized, so that it is probably safe to state that the length seldom exceeds 150 ft. and the width usually ranges from 35 to 40 ft., while the depth is usually 6½ or 7 ft.

The boats contain all the necessary machinery for operating the spuds, drills and anchors and have a sufficient coal capacity for a run of several days. The boiler, pumps, winch engines for shifting position, the coal bunkers, sharpening apparatus and all auxiliary equipment are usually placed on the barge opposite the drills, thus balancing and making the outfit self-contained.

### Evolution of Drill Barges

It may be of interest to review briefly the history of this type of boat. The pioneer in the modern drill-scow method of submarine rock excavation and constructor of the drill scow substantially as it stands today was C. F. Dunbar, of Buffalo, N. Y. About 1866 Mr. Dunbar undertook the removal of rock from the channels at the harbor of Erie, on Lake Erie. He drilled and blasted a portion of the rock through the ice, in winter time, and when there was no ice, used a raft for the purpose. All the drilling was done by hand. The average depth of the excavation in the rock was about 6 ft. In 1872 Mr. Dunbar undertook further excavation at the harbor of Port Colborne, on Lake Erie. An attempt to drill by hand failed, because the rock was found to be so hard that three men could drill only about 1 ft. in a day. During the following winter he converted an old 50-ft. dredge into a drilling scow, which was very similar in its main features to the boats used today. This boat employed spuds at the corners and two steam drills mounted in towers arranged for both longitudinal and vertical feed. The

drilling machines were raised and lowered by a hand-operated windlass and the towers were moved along the track with the aid of crowbars. The boat was enabled to drill ten holes, spaced 5 ft. apart at one setting of the scow. The drill feed was 9 ft. Some seven or eight years later Mr. Dunbar improved his boat by the addition of a hydraulic ram with which to move the drills both vertically and horizontally, and by the use of a steam pump to force water into the drill holes for the purpose of keeping them free of cuttings and débris.

### Handling Drill Boats

The barge is anchored by means of cables, anchor chains or spuds, or a combination of these means, depending on local conditions. In very swift currents chains have been found more advantageous as breasting lines than wire cables, as they are less severe on the breasting gear while shifting position. The greater weight of the chain permits an amount of spring or elasticity that would be absent with the lighter cable.

In operation the barge is brought into approximate place, anchors are dropped and winches used to move the barge into exact position. The heavy spuds are dropped to the bottom after the boat is properly located over the work. The barge is then lifted until a sufficient fraction of its weight is supported by the spuds so as to insure holding it in a fixed position. Usually a lift of 5 or 6 in. is sufficient to hold the barge steady. These spuds are made either of structural steel or of timber and have the lower end fitted with a steel point or iron shoe intended to penetrate the surface.

The drills are mounted in wooden or structural-iron towers and have effective feeds of various lengths up to about 25 ft. At first the drills were raised and lowered by hand-operated windlasses, but later a hydraulic lift cylinder connected to the backing of the drill became the common means of raising the machine in the guides, the down feed being accomplished by gravity. With later types, steam hoisting engines have been adopted and are considered by many to be more satisfactory. They certainly require less power and enable boats working in colder climates to remain in operation for a longer season, steam-driven machinery not being so easily subject to trouble from freezing as hydraulic machinery.

The drill towers rest on rails running the length of the barge and fastened to the deck. There are the necessary means for clamping the towers in different positions along the rails. Each has vertical guides on which slides a heavy cast-iron saddle, to which the drill is bolted. In the steam type, ropes or cables, passing over one or more sheaves on top of the tower, connect this saddle with the drum of the hoisting engine. The drill-feed regulation is controlled by a brake lever on the hoisting engine operated by foot. By this means the feed can be regulated to a nicety, and it also insures rapid handling when the steel must be lifted from the hole. Engines for this purpose are also built with throttle reverse.

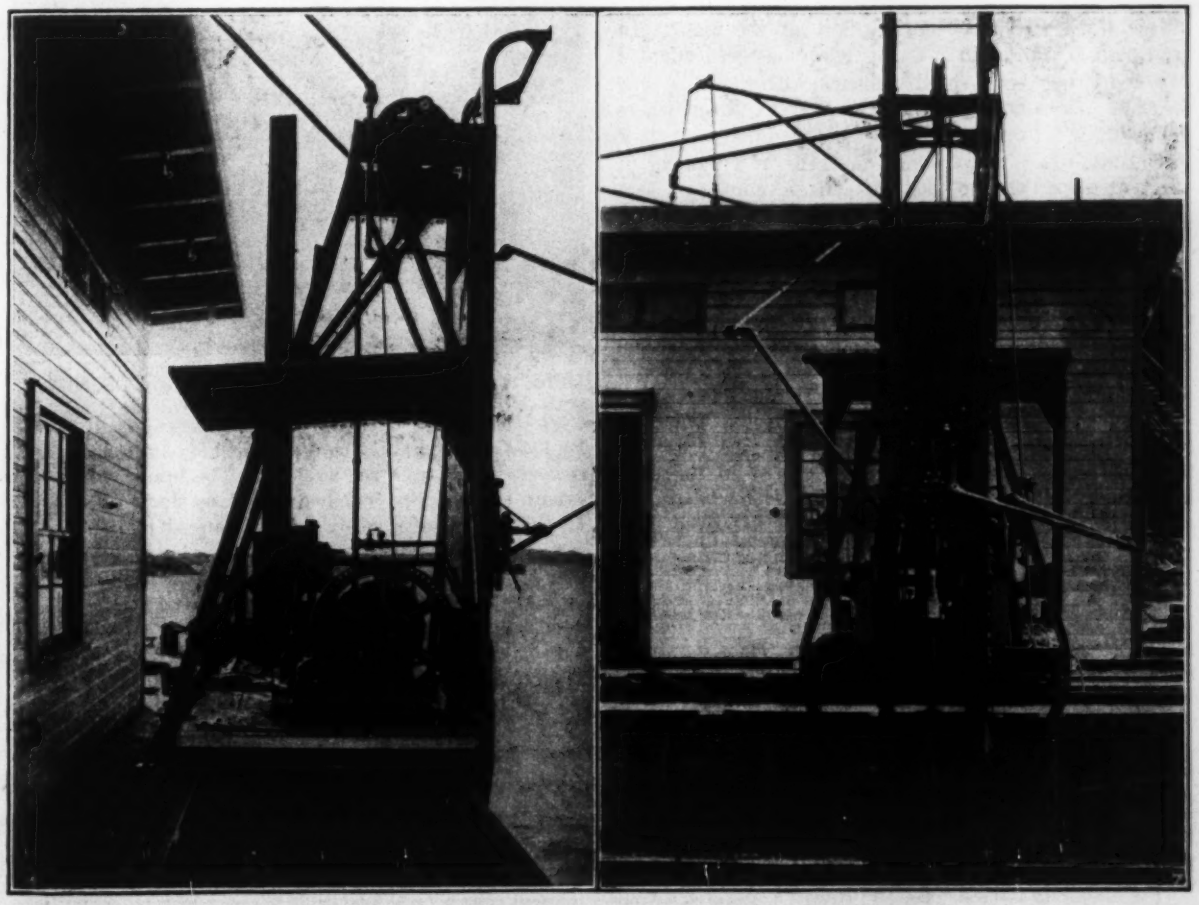


FIG. 7. FRONT AND SIDE VIEW OF DRILL TOWERS ON MISSISSIPPI BOAT

When this type of engine is employed it is advisable to employ a balanced-throttle valve, so that the engine can be turned a small amount in either direction when desired, by applying slight pressure on the valve by hand.

Fig. 7 shows the construction of a drill tower on the boat illustrated in Fig. 4. The drills on this boat are not

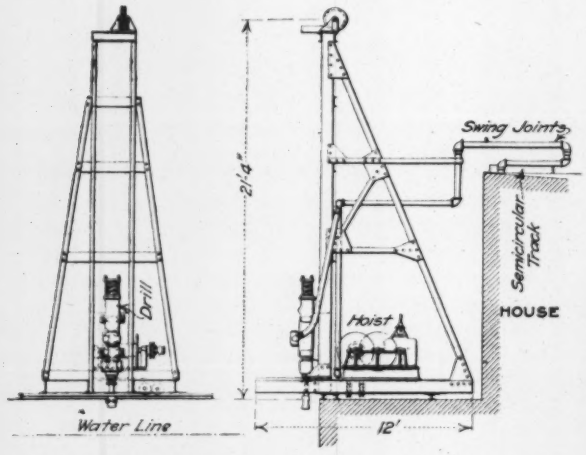



FIG. 8. WAGON TOWER USED ON MOHAWK RIVER DRILL BARGE

of very large size, having only 4¼-in. cylinders, and the tower illustrated is therefore of relatively small size. The views, however, serve to illustrate clearly the principle of operation, irrespective of the size of the plant. In some cases a regular drill-wagon tower has been adapted as a mounting for a small submarine drill. This type (Fig. 8) was used for work on the Mohawk River, where the depth of cut was moderate.

The towers are moved along the rails in a number of different ways. One method for shifting employs a separate wheel on the hoisting engine which engages with a chain secured to the deck at either end of the drill-tower runway. The chain wheel is connected to the hoisting engine by means of a jaw clutch, the chain passing over guide wheels in the base of the tower. This is an efficient and rapid means of moving the frame in either direction. Fig. 7 shows how a rack on the deck engaging a cog wheel on the drill frame is utilized for the same purpose.

In the older system of hydraulic control a hydraulic cylinder is used instead of the hoisting engine (see Fig. 9). The supply pump for this is located in the deck house and the water pipes leading to the tower are arranged in very much the same manner as described later for steam control. The same sizes of drills, and operated by steam in the same way, are used whether steam or hydraulic control is employed for the drill towers.

### Piping Arrangements for Drills

The movements of the drill tower along the deck and of the drill up and down in the guides necessitate flexible steam and hydraulic connections, so that the pipes will automatically adjust themselves to any position of the tower. A variety of methods is in common use, such as short lengths of hose, telescopic pipes, or arrangements of swing-jointed pipes (Fig. 10). Any one of these arrangements provides for the vertical as well as horizontal movement of the drill. The controlling valve for the steam is located within convenient reach of the operator.

FIG. 9. HYDRAULIC THROTTLE CONTROL ON DRILL BARGE

By locating the main steam pipe inside of the deck house it is protected from the weather. The branch pipes may extend through the deck-house roof, as shown in Fig. 10. In that view the pipe lines are arranged in pairs. One

PERFORMANCE OF THREE DRILL BARGES ON DETROIT RIVER IMPROVEMENT

| Boat | Spacing of Holes | Average Total Depths of Holes, Ft. | Depth Drilled Below Pay Grade, Ft. | Holes per Shot | Charge per Hole | Av. No. Holes Drilled per Shift | Lin.Ft. Drilled per Shift | Depth per Drill, per Hr., Inc. Delays, Ft. | Speed, Ft. per Hr., Inc. Setting, Cutting and Loading | Ratio Cutting to Total Time | Ratio, Moving Boat on Range to Total Time | Ratio Idle (Not Inc. Moving) to Total Time | Av. Cu. Yd. Pay Rock per Shift |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1* | 5 ft. on deck; 4½-ft. move-over | 9½ | 3 | 650 | 12 20-oz., 60% sticks | 52 | 510 (average) | 9.3 (average) | 16.8 | 0.669 | 0.091 | 0.24 | 280 |
| 2† | 5x5 ft. | 12.1 | 3 | 228 | 20 20-oz., 60% sticks | 32½ | 390 | 8.9 | 13.4 | 0.588 | 0.013 | 0.399 | 270 |
| 3‡ | 5x5 ft. | 12½ | 2½ | 396 | 17 18-oz., 60% sticks | 25 | 310 | 7.1 | 14 | 0.512 | 0.028 | 0.46 | 232 |

* Buffalo Dredging Co.'s all-steel boat No. 5—138x31½x6½ ft.; steel house 19x110 ft.; four spuds with 6x8-in. steam engines; two steam capstans; two Scotch boilers, 90-lb. gage pressure; pump, blower, forge, steam hammer, anvil, bench, vise, acetylene plant, etc.; five Ingersoll-Rand 5½x8-in. drills; drill feed, 19 ft.; Dake steam hoisting engine; 2-in. x 34-ft. steels; 3½-in. bit gage; ¾-in. waterjet; crew of 5 drillers, 4 helpers, 2 blasters, foreman, fireman, smith and 2 smith's helpers; 10-hr. day shifts and 12-hr. night shifts.

† Dunbar & Sullivan's "Hurricane" (Fig. 2)—All-steel, 100 ft. long; four spuds with engines; two steam windlasses; two Scotch boilers, 90-lb. gage pressure; three pumps, blower, forge, anvil, bench, vise, dynamo, etc.; two Ingersoll-Rand 5½x5½-in. and two Ingersoll-Rand 5½x6½ drills; 19-ft. drill feed; hydraulic-ram hoist; 1¼-in. x 35½-ft. steels; 3½-in. bit gage; ¾-in. waterjet; crew of 4 drillers, 4 helpers, foreman, fireman, powderman, smith and 2 smith's helpers; two shifts of 11 hr. each.

‡ M. Sullivan's all-steel boat "Destroyer"—110x33½ ft.; four spuds and engines; two steam capstans; Scotch boiler for 100-lb. gage pressure; two pumps, blower, forge, anvil, bench, vise, dynamo, etc.; four Ingersoll-Rand 6½x9-in. drills; 19-ft. drill feed; hydraulic-ram hoist; 2½ and 2¾-in. by 36½-ft. steels; 4 and 4½-in. bit gage; ¾-in. 150-lb. waterjet; crew of 4 drillers, 4 helpers, foreman, fireman, blaster, smith and 2 smith's helpers; two shifts of 11 hr. each.

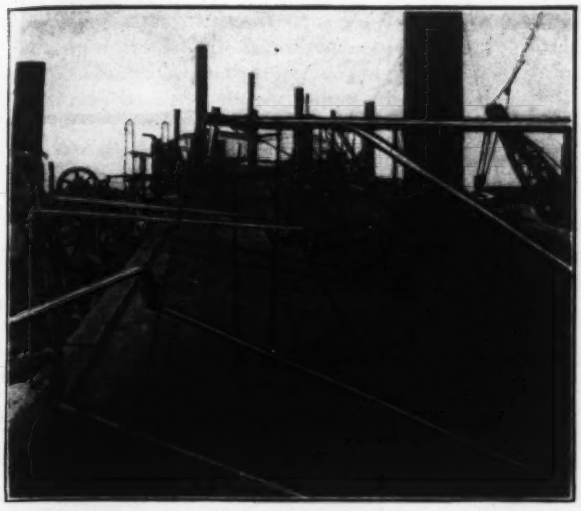


FIG. 10. FEED PIPES AND SWING JOINTS, MISSISSIPPI DRILL BARGE

supplies steam to both hoisting engine and drill. There are three swing joints between the deck-house roof and tower and three more between the hoisting engine and drill. The second pipe supplies water under high pressure for the washout jet and is similarly equipped with swing joints. The movement of the swing joints is facilitated by swinging-crane adjustment (Fig. 10) or by a guide track bent into a semicircle upon which the jointed pipe slides. The steam pipes should be protected by nonconductive material as far as practicable so as to reduce the loss of heat by radiation.

### Drill-Barge Performance Records

The boats employed on the Livingstone improvement of the Detroit River are representative of the types under discussion. Therefore some figures are appended from the records of three typical examples of the many boats employed on this job. (See Dana & Saunders' "Rock Drilling," Wiley & Sons, New York.) The three boats were owned by different contractors. The channel cut was 23 ft. deep, 300 ft. wide and was on the 18,250-ft. long section of the job known as Section 3. The rock is a hard limestone having 1 to 2 ft. of sand overburden. The work was divided into three strips, each 100 ft. in width, and each of the boats referred to was employed on a part of one of these strips.

### Subsequent Notes

The later articles on subaqueous drilling will discuss (1) drills and drilling machinery, (2) work in tidal waters with submarine frames, (3) drilling from platforms raised above the waves, and (4) the use of drill pontoons in shallow waters. Indebtedness is acknowledged to the sources of information already indicated. In addition special acknowledgment should be made to Charles C. Hansen, of Phillipsburg, N. J., who furnished much of the detailed information.

**Protecting the Water-Supply of Caracas**—The government of Venezuela has appropriated about $16,000 for the purchase of two farms situated upon one of the watersheds that supply Caracas. According to United States Consul Homer Brett, of La Guaira, these farms will be depopulated and reforested as a part of an effort to improve the water supply and decrease the high death rate of Caracas.

## Lead and Tar Paints Compared on Minidoka Project*

By Barry Dibble†

The painting of the penstocks and draft tubes of the Minidoka turbine installation has been a source of considerable trouble. Several trials were made before anything was found which would withstand the action of the water.

The shop paint was of red lead, or iron oxide, and oil. A further coat of red lead and oil was applied on the job, after assembling and riveting the pipes. After two years' service an examination showed that this paint had practically disappeared. After considerable study and experiment, with unsatisfactory results, the following formula for red-lead paint, obtained from one of the largest paint manufacturers in the country, was adopted, the lampblack being used as a hardener for the surface:

First Coat—30 lb. red lead per gallon of linseed oil, using one-third boiled and two-thirds raw oil.

Second Coat—Same as above, with 4 oz. of lampblack per gallon.

Third coat—Same as above, with 4 lb. of lampblack to the gallon.

Paint was applied according to this formula during the winter 1912-13. After part of this work was done the chief electrical engineer suggested that we try the material used on the Los Angeles Aqueduct (see article on San Fernando Siphon, *Engineering News*, May 21, 1914), and in accordance with his instructions we ordered water-gas tar for the first coat and coal-gas tar for the second and third coats. This was applied to penstock and draft tube No. 1.

At the end of the 1913 season the red-lead paints applied according to the above formula showed decided deterioration where in contact with water, while the tar was in very good shape, except for slight rust spots around some of the rivets, where cleaning evidently had not been properly done. At the end of the 1914 season the lead paint had almost entirely disappeared where exposed to water and the tar paint was in good condition on the penstocks, but was apparently getting rather thin on the outside of the draft tube. Where the red lead does not come in contact with the water, as is the case on the upper part of the exterior of the draft tubes, it shows no deterioration and is now in excellent condition.

During the fall of 1914 the parts exposed to water on all the draft tubes were scraped, cleaned and repainted with water-gas and coal-gas tar. There was a considerable variation in the condition on the different tubes, due to the fact that some had two coats of lead and some three, and also due to the fact that in some cases the weather was cold when the paint was applied, and it therefore may not have set sufficiently before being submerged in the water. The tar paint on draft tube No. 1 would, under ordinary circumstances, have gone a much longer time without renewing, but it was thought advisable to go over it in order to determine what condition the tar coating was in, and also to find out what was the condition of the iron underneath.

Cleaning was done by means of steel scrapers and brushes. With the lead paint the iron pitted badly, and it was necessary thoroughly to clean out the loose scale

*From United States Reclamation Record, September, 1915.

†Engineer in charge of power and pumping stations, Minidoka Project.

before attempting to repaint the metal. The rivet heads particularly presented a serious difficulty with these scrapers, and we found it very slow to do a good job cleaning around them. After finishing this work on the draft tubes, a special brush was made up which could be fitted over the rivet heads and revolved in a breast-drill frame. This worked satisfactorily, and it materially reduced the cost of cleaning the penstocks.

The men working on this scraping were affected by lead poisoning, and precautions had to be taken to make their work intermittent. Even at that it was necessary for some of them to lay off for a considerable time to overcome the effects of the lead dust. After thoroughly scraping the iron, it was brushed down with scratch brushes, to remove the loose scale, but no attempt was made to get off all the dust prior to applying the water-gas tar.

In scraping draft tube No. 1 we found an excellent adherence between the metal and the tar paint, which had been on 1½ yr. at that time. Where it was scraped down to the metal it left a bright surface. On one patch, of about 1 sq.yd., apparently the iron had not been well cleaned before applying the paint, as it was in a place difficult to reach, and here scale had formed on the iron, but this was the only place the iron had not been protected from the water. Altogether, the results with the tar have been most satisfactory.

There was quite a variation in the consistency of the water-gas tar purchased at different times. As ordinarily obtained, it was necessary, in the cool weather during which we painted, to mix a little gasoline with it. Usually the mixture was about 1 qt. of gasoline to from 3 to 5 gal. of tar. This tar was then spread on carefully with a brush in the same manner as ordinary oil paint, working it carefully into all pits and around rivets. One gallon of tar covered about 30 sq.yd. with one coat. The cost was about 15c. per gal., about one-half of which was freight charge from Chicago to Minidoka.

The tar is rather slow in setting even if the weather is warm. It hardens when the thermometer drops, but when the weather warms up will become sticky even after a considerable period. As most of our work was done in cool weather, it was possible to apply the second coat within 10 to 14 days. In only one case (No. 4 draft tube) were we able to get a third coat on prior to the time when the weather turned so bad that it was impossible to do outside work. It does not appear to affect the tar to put it into the water before it is thoroughly hardened.

The Reclamation Service is now testing this tar coating on a number of structures, both earth covered and exposed to the weather, under different conditions as to extremes of temperature, alkali action, etc.

## Reinforcing Details of Delco Building, Dayton, Ohio

A carefully planned factory design, a flat-slab floor system containing new elements, and some interesting reinforcement details are found in the new Delco Building being erected in Dayton, Ohio. Schenck & Williams, of Dayton, are the architects. Nelson J. Bell is the structural engineer for the architects. A. Bentley & Sons Co., Dayton, Ohio, is the contractor.

The building is 423x93 ft. over all, extending between First and Second St. and facing on Race St. The general scheme involves a future extension to the next street east by the construction of a duplicate building plus a 22-ft. connecting bay. The completed building will be 423x203 ft. over all, with an interior court 61x237 ft. Features of the layout are: Clear floor areas without partitions; maximum sash area with windows extending up to the ceiling (spandrel beams above the floor, bottom flush with ceiling); the omission of a

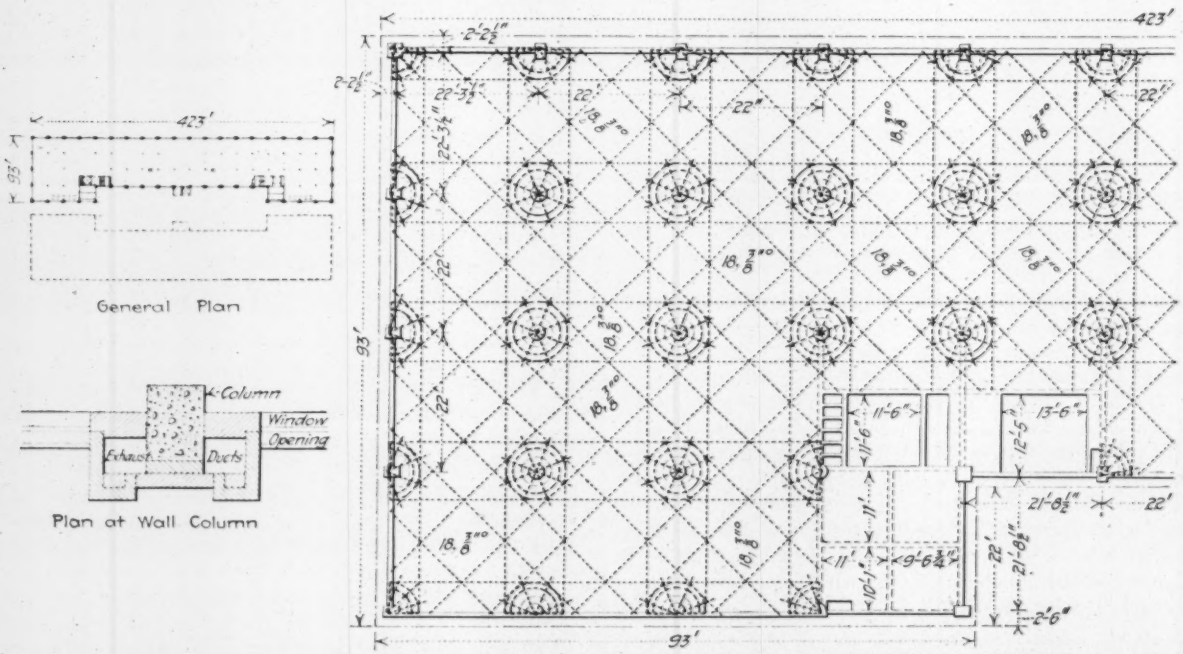



FIG. 1. FLOOR ARRANGEMENT AND FLAT-SLAB REINFORCEMENT OF NEW DELCO FACTORY BUILDING, DAYTON

basement on the theory that a floor above ground where it gets natural light is worth more than a floor below ground; and an original arrangement of the blast heating and ventilating system, with vertical heat ducts rising from plenum chambers in the center of the building and vertical vent ducts at all the wall columns.

Structurally the floors represent a flat-slab system similar to those heretofore in general use, but differing from them in some details. The column heads, like the columns, are circular and contain ring rods as well as radial rods. The radial rods do not bend down into the columns, but cross at the center (note bend in middle, in Fig. 2). Bands of rods extend in four ways, in the directions of the column rows and in the two diagonal directions.

The radial rods will be supported on little bent-iron chairs, as sketched by a detail in Fig. 2. The belt rods will be kept up off the floor-forms by pieces of cross-rods.

A feature of the ceilings is the enormous number of ceiling inserts for attaching shaft-hangers and the like. The inserts are to be placed 18 in. apart in both directions, making approximately 14,000 per floor. In the present Delco Building (just north, across First St.) the inserts are spaced 2 ft. apart both ways, and it is claimed that for the conditions peculiar to the plant they have been found insufficient, so that a closer spacing was adopted for the new building.

The ceilings are flush and level with the tops of the windows. The beams around the elevator wells and stair-shafts project below the ceiling, but all of these are flush with the shaft walls. Both spandrel beams and cornice are above slab level. A novel form of assembled reinforcement is used for all beams, as shown by the sketch in Fig. 2. The straight and the bent-up girder rods are connected from each quarter point to the end by a zigzag of stirrup-bar looping, which, however, is wrapped around both rods so as to make the assemblage a unit. This looping is bent before assemblage, and is then slipped over the main rods and jammed fast.

As the spandrel beams had to connect to the columns, it was necessary to place the vent ducts (at exterior columns only) outside the window line, as indicated by the enlarged section in Fig. 1. This has the advantage of giving deep vertical reveals and thus favoring the architectural development of the exterior, but it meant that the basement retaining-wall had to be set out from 1 to 2 ft. The wall, as shown by a detail sketch in Fig. 2, occurs only at the heater and fan room space. Under the rest of the building there is no basement except the heat tunnels and the plenum chambers, but the concrete forming the ground-floor surface is laid directly on the natural ground. Here the inclosure walls reaching up to the first-story window sills have the same general shape and detailing as the basement retaining-wall sketched.

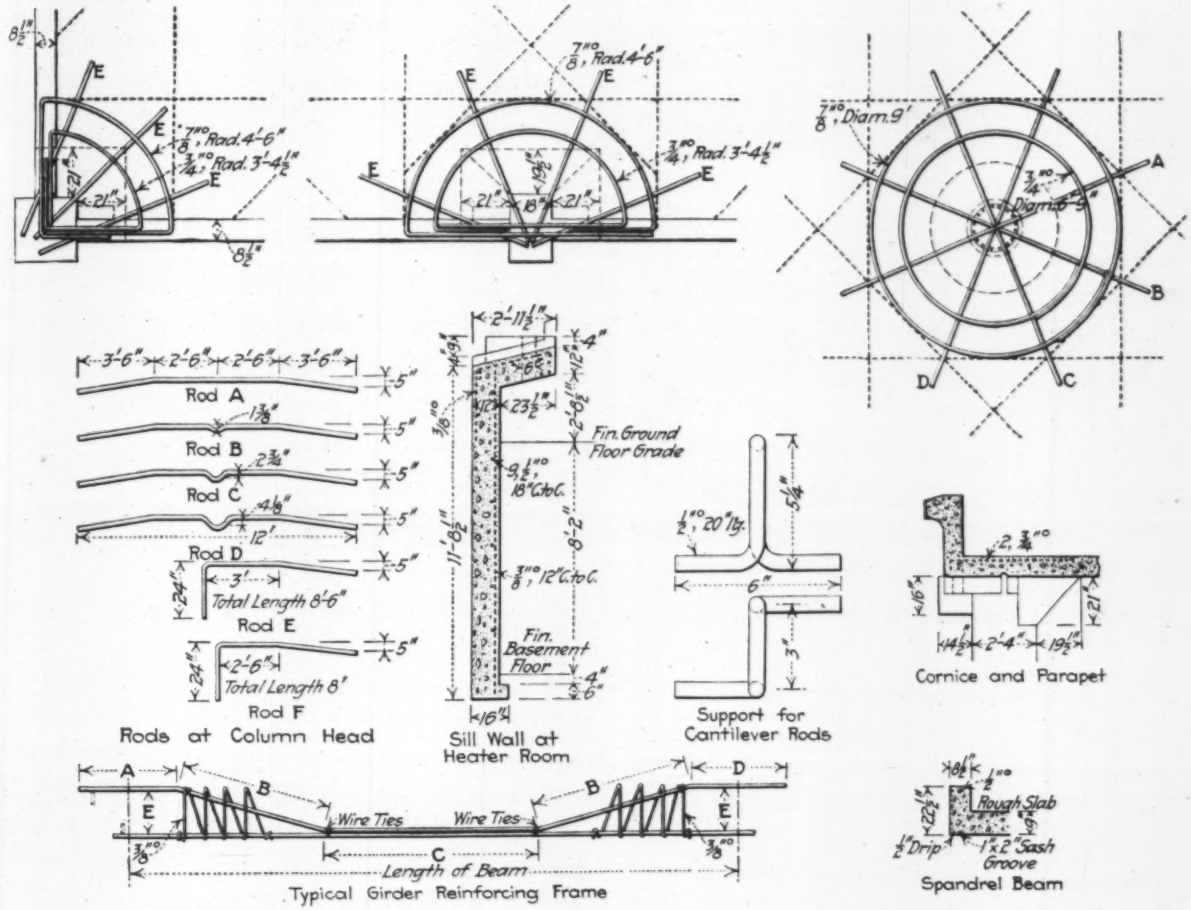



FIG. 2. DETAILS OF REINFORCEMENT IN COLUMN HEAD AND GIRDERS; SILL AND CORNICE SECTIONS

# Rebuilding a Burned Oil Tank

By C. P. Bowie*

*SYNOPSIS—A 30,000-bbl. petroleum tank was set on fire by lightning. The fire burned for over 11 hr. The damage done to the tank is described and also methods adopted for its reconstruction.*

If one has ever watched a mass of crude petroleum in process of combustion, he cannot but be impressed by the extreme ferocity with which it burns and the consequent intensity of the heat generated. It is therefore interesting to note just what the results of such a severe test might be on the shell of an ordinary steel tank, such as is used for storage, and it is the purpose of this article to describe, as nearly as possible, the actual condition in which such a structure, having passed through a fire, was found to be when the flames had burned themselves out and the metal cooled sufficiently to permit of examination; also the work required and method pursued to reconstruct the tank.

On the afternoon of Dec. 10, 1914, the vicinity of the Associated Pipe Line Co.'s Levis pumping station, situated in the San Joaquin Valley, California, about 40 mi. northwest of Fresno, was visited by an electrical storm of comparatively short duration and what seemed not unusual intensity. After an especially heavy clap of thunder immediately following a vivid flash of lightning the roof of the storage tank was seen to be a mass of flames. Already great clouds of inky black smoke were soaring skyward.

The tank had a capacity of 30,000 bbl. and was about one-third filled with oil of 16° Bé. gravity. It was situated at a distance of about 300 ft. from the pumphouse and was entirely surrounded by a levee 6 ft. in height, 4 ft. wide on the top, 16 ft. wide at the base, and at such distance from the tank as to impound about one and one-third the contents of that structure.

Steam was immediately turned into the tank through the smothering line, but the wooden roof burned so rapidly that the attempt to extinguish the flames by this method was ineffectual. The 6-in. bleeder in the bottom of the tank was then opened and oil allowed to run out into the surrounding basin. This was done to prevent the water on the bottom of the tank forming steam bubbles and causing the oil to boil over. The pumps were run at full capacity, drawing oil from the tank as long as was deemed expedient. The machinery was then shut down, the station being bypassed so as not to tie up the system, and the doomed tank was left to its fate. No attempt whatever was made to fight the fire with water, and fortunately the rain accompanying the thunder storm was of short duration. Therefore the metal that remained intact when the fire was over and that might be used in reconstruction could be allowed to air-cool on the passing of the flames and not be injured by sudden chilling.

The fire started at 3:55 p.m. on the 10th and burned itself out at 3 a.m. on the 11th, having lasted 11 hr. 5 min.; by the morning of the 14th the metal had cooled sufficiently to permit of examination.

The tank was 86 ft. in diameter and 30 ft. in height. The shell was composed of six rings of steel plate, each ring containing 24 sheets approximately 5 ft. 3 in. by 11 ft. 6 in. The roof and roof supports were made of wood, with a waterproof covering of ordinary roofing paper.

A review of the specifications reveals the following facts:

| Part | Dimensions | Diameter of Rivets, In. Seam Vertical | Seam Horizontal | Rows of Rivets Seam Vertical | Seam Horizontal |
|---|---|---|---|---|---|
| 1st ring | 14 lb. per sq.ft. | ¾ | ¾ | Double | Single |
| 2nd ring | 12 lb. per sq.ft. | ¾ | ¾ | Double | Single |
| 3rd ring | 11 lb. per sq.ft. | ¾ | ¾ | Double | Single |
| 4th ring | 10 lb. per sq.ft. | ¾ | ¾ | Double | Single |
| 5th ring | 8 lb. per sq.ft. | ¾ | ¾ | Double | Single |
| 6th ring | 8 lb. per sq.ft. | ¾ | ¾ | Single | Single |
| Bottom sketch plates | No. 4 gage | ¾ | | Single | |
| Bottom rectangular plates | No. 6 gage | ¾ | | Single | |
| Top angle | 3x3x⅜-in. | ¾ | | Single | |
| Bottom angle | 4x4x½-in. | ¾ | | Single | |

The manhead in the bottom ring was 20 in. in diameter, of ½-in. plate with welded seam and closed by ½-in. flat plate and ¾-in. bolts. The tank had four 8-in. pressed-steel flanges secured to the shell with ¾-in. rivets. The bottom had one 6-in. flange with ½-in. rivet. An iron ladder was riveted to the shell from ground to top. All rivets over ⅞-in. were driven hot, and all were driven on the outside of the tank except for the bottom.

As will be seen in the accompanying views, the heat of the burning oil curled the shell of the tank inward so that when the fire had passed, the top angle iron and in places a large part of the top course rested on the bottom of the tank. The deformation began near the top of the second ring (counting from the bottom upward) and extended to the top of the tank. The photograph of Fig. 6 was taken from a point inside the tank near the center, looking toward the shell. In the foreground of the picture can be seen the remains of the swing (or suction) pipe, the winch box and the iron ladder. The inspecting engineer's report on material and work

*619 Sharon Building, San Francisco.

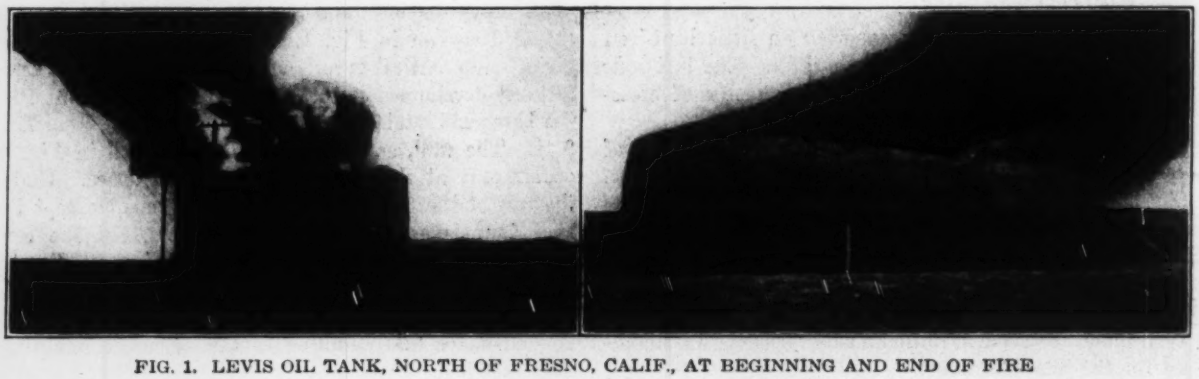
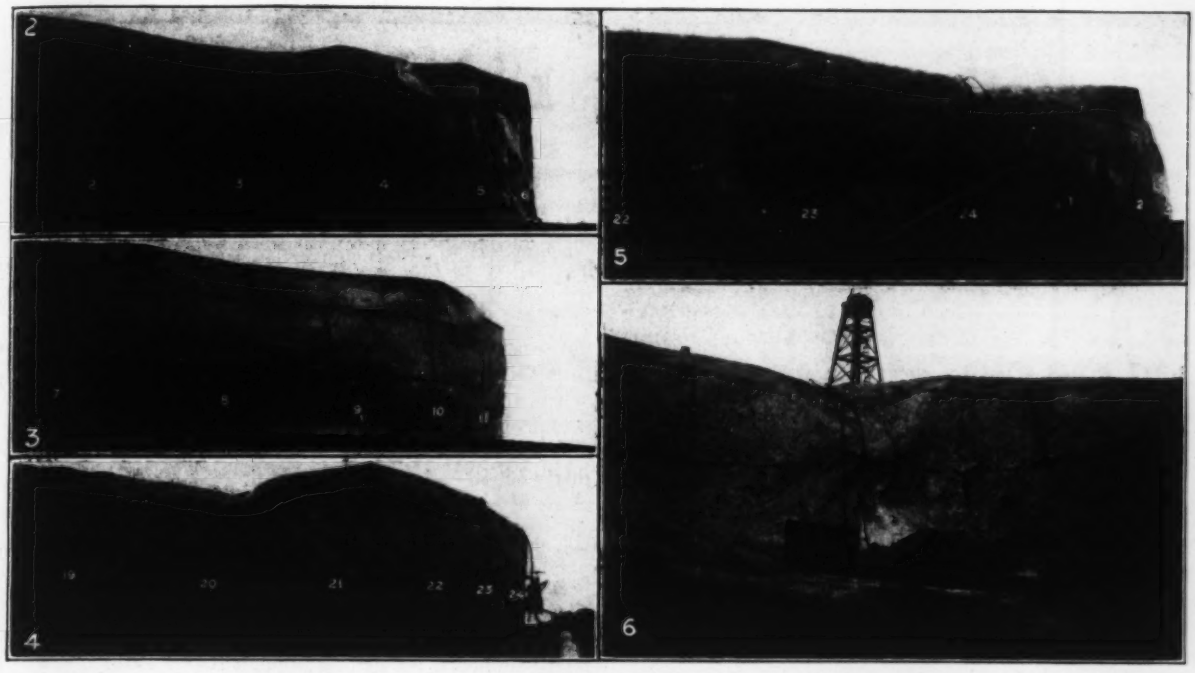


FIG. 1. LEVIS OIL TANK, NORTH OF FRESNO, CALIF., AT BEGINNING AND END OF FIRE




FIGS. 2 TO 6. VIEWS OF THE LEVIS OIL TANK AFTER ITS DESTRUCTION BY FIRE

Figs. 2 and 3—Outside of shell; numbering corresponds to inspecting engineer's report. Fig. 4—Suction-nozzle valve, suction pipe and manhead. Fig. 5—Tank ladder and suction-nozzle valve. Fig. 6—Interior of shell, top course resting on bottom sheets

required for reconstruction showed that the tank bottom was badly warped, but that the bottom angle iron and angle-iron shoes were in good condition. The engineer recommended cutting the bottom sheets apart, reriveting and calking. Sheets 1 to 17 in the first course (counting from the bottom up and from the 18-in. nozzle toward the manhole) were good. Sheets 18 and 19 were warped, but could be straightened and used. Nos. 20 to 24 were good. In course 2 sheets 1 to 15 (counting the same way) were fairly good and 16 to 18 were badly warped, but all could be straightened. Sheet 19 was so highly heated and buckled that it was thrown out. Nos. 20 to 24 were fairly straight. All the sheets in courses 3 to 6 were damaged beyond repair. The 18-in. nozzle and 8-in. flanges could be cut off, reriveted and calked. The swing pipe and all fittings, a 45° flange on the shell and a 4-in. pipe and strainer, were entirely useless. The ladder could be used, though badly bent and burned in two at the top.

The work of reconstruction was done under contract by the Llewellyn Iron Works, of Los Angeles. The material in the four upper rings of the tank was cut into strips of convenient size, lifted over the remaining portions of the shell and discarded. It was the intention to do this work with air tools, but on account of heavy rains the compressor was so greatly delayed in arriving that the cutting was done by hand. The rivet heads were cut off and the remainder punched through. Where it was not practical to follow along the seams the plates were cut.

The sheets of the two lower rings and the bottom were then entirely cut apart. Of the bottom only a few plates required to be straightened. In the first course 12 plates and in the second course six plates required reworking. This was done by placing the sheets on a heavy wooden form made of 4x12-in. pine planking placed on edge and hewn, in the case of the side plates, concave to conform with the circumference of the tank shell. The plates to be straightened were bolted to this form and hammered with sledges, a flatter being interposed in order to avoid injury to the plates.

Some plates were replaced in the bottom and a few more in courses 1 and 2 than recommended by the inspecting engineer. Otherwise the specifications for reconstruction were framed essentially along the lines of his suggestions. All the old sheets were rebeveled before being calked. The 18-in. valve on the suction and the 8-in. valve on the filling line, both of which were on the outside of the tank near the bottom, were practically unharmed and required only to be overhauled and repacked before being put back into place. It was a matter of frequent comment among those connected with the work of reconstruction how remarkably well the rivet holes in the worked-over plates matched, there being in most cases practically no necessity for reaming.

The tank, when completed and given a fresh coat of paint, was to all appearances wholly new and in as good condition as it was before the fire. In fact, had it not been for the baked and discolored appearance of the ground upon which the structure stands and the abundance of cinders and ashes strewn in its basin, one would not suspect that any part of the present shell had passed through the flames.

No laboratory tests were made on the sheets. All sheets requiring straightening, however, were inspected for cracks, etc. No plates were found injured by the straightening. Previous experience of an affiliated company had shown that metal that had cooled slowly and that was not actually oxidized by the flames or warped beyond possibility of reworking was of sufficient strength.

The saving of this reconstruction over discarding all the old material was about $1,200.

# Engineering Literature

## Library Files of Periodicals

Sir—An editorial in *Engineering News* of Oct. 21 (p. 788) calls attention to the important catalog of technical periodicals issued by the Library of the Engineering Societies and to the great amount of information to be found in periodical literature.

From this catalog the following statistics have been compiled: There are 956 periodicals complete in some one of the seven New York libraries covered by that catalog; 43 periodicals are not complete in any one library, but the parts missing in one are to be found in some other library in the city; 1,067 are incomplete in all libraries. The total number of periodicals is 2,066 and the number of sets 4,236. In those sets there are 3,086 part volumes and 43,109 whole volumes, a total of 46,169 lacking.

If it were desired to complete at least one set of every periodical, it would be necessary to procure 1,290 part volumes and 11,000 whole volumes—a total of 12,290.

Evidently there are large gaps in the collections of New York City, nor will other cities fare much better. Even old libraries lack many volumes. For instance, the Library of the Royal Society of London, whose catalog of periodicals published in 1912 contains 1,811 titles, shows 240 part volumes and 842 whole volumes lacking.

Every librarian knows how hard it is to fill gaps in sets. A clearing library for technical and scientific periodicals would prove of great value. Such a library, supported by all other libraries, could purchase from second-hand dealers, publishers of periodicals and private persons sets both complete and incomplete and receive from the libraries all duplicate sets or parts of sets. In case it were found that additional volumes of periodicals could not be procured and were needed by a number of libraries, they could be reproduced by some inexpensive process by the clearing library.

Here is a fine opportunity for someone wishing to devote money for a useful purpose. It is very well to establish libraries of all sorts, but libraries will be of little use to workers if needed publications are not available.

A. FANTI,
Librarian, United States Bureau of Standards.

Washington, D. C., Oct. 30, 1915.

## Books for the Practical Man

BY ANTONIO LLANO*

Of the many calamities that the unschooled practical man is heir to, few are so harmful or so disgraceful (not, of course, to him) as the imposition constantly practiced on him by publishers of worse than worthless books claiming to teach, in simple style which his untrained mind can readily comprehend, all the mathematics that he needs. The authors of such books, being ignorant, would be better occupied in learning than in teaching; a little education would enable them to accomplish their purpose, which is exclusively to add a few dollars to their sorry income, with more credit to their reputation and less injury to others. It is charitable to assume that, themselves afflicted with the blindness they would cure in their companions, they act in good faith, and that the deception they perpetrate on their customers arises from their own self-deception. But this charity cannot be extended to the publishers, whose duty it is to have competent experts as critics and advisers. They ought to be unqualifiedly condemned for publishing books which may justly be characterized as impostures—a character all the more blamable as these books are intended for men at once ignorant and poor.

I shall illustrate this disgraceful situation by reference to a book on mathematics that claims to be "practical." The author, who does not understand that the letters used in algebraic expressions are convenient symbols to represent numbers, teaches the student that a letter is a sort of abbreviation for the name of "some object or thing." "In arithmetic," he says, "we would say, if one hat costs 5 cents, 10 hats cost 50 cents. In algebra we would say, if one $a$ costs 5 cents, then $10a$ cost 50 cents, $a$ being used to represent 'hat.'" He further illustrates by saying that if a man has 5 tables and 10 chairs, he may write $a$ for *tables* and $b$ for *chairs* and say that his stock is $5a + 10b$. This is algebraic addition. In arithmetic, he continues, we cannot multiply one table by one chair, for arithmetic can give us no "conception as to the appearance of the object" that would result from so strange an operation. But "in algebra all this is simplified"; all we have to do is to write $a$ for *chair* and $b$ for *table*, and then "the expression $ab$ represents in its entirety the multiplication of a chair by a table."

The student is practically given to understand that the constant 3.1416 is an experimental coefficient; for, according to the author, this number is found by "comparison between the lengths of the diameter and circumference of a circle made with the utmost care." Perhaps the author, not knowing how to write, did not intend to convey this idea, but he does convey it. I saw once a similar statement, though more explicit, made by one of the many "practical and theoretical, long-experienced instructors" (young girls just out or not yet out of school) of a notoriously and deservedly unhappy correspondence-instruction concern. In answering an inquiry, this "expert," who "taught" many branches of engineering, said very knowingly and concisely: "The number 3.1416, like many others used in practical formulas, is an empirical constant."

In the book under consideration the student learns further that "an equation is the expression of the equality of two things"; that "a polygon bounded by four sides is called a quadrangle"; that "the addition of two right angles makes a straight line;" that "two triangles are seen to be equal if one side and the angle opposite to it of the one are equal to one side and the corresponding angle of the other"; that the logarithm of 0.0438 is writ-

*1041½ Park Ave., Saranac Lake, N. Y.

ten —2.6415, although "the —2 does not carry its negativity to the mantissa"; that, with the directrix or some other line to the left of the vertex as the axis of $y$, the equation of a parabola is of the form $y^2 = ax$; that the integral of sin $x\ dx$ is $+\cos x$; that the integral $\frac{dx}{x}$ is the *common* logarithm of $x$ (and, that there may be no doubt, this is illustrated by numerical examples); that all equations of a degree higher than the second "represent a large variety of curves called cubic curves"; that a differential is an inconceivably small quantity, "less than one millionth or one billionth"; that a differential is the same thing as a rate; that $g$ is a rate and therefore a differential, which may be called $dx$; that in this case $dx = 32$ ft. per sec., and therefore 32 ft. is an inconceivably small quantity; and many other curious things, after which comes the awful declaration that "the student may not understand at first the theories herein treated of."

The style of the book is wretched; a mixture of crudity, which the author mistakes for simplicity, and fustian, which he mistakes for learning. Rhetoric in general, and grammar in particular, are conspicuously missing in his equipment, and this, although affording something more for the educated reader to laugh at and therefore enjoy, greatly increases the difficulties of the would-be learner.

Let it not be thought that I have devoted too much attention and space to a worthless book. For that book is typical of a large class of abominable publications that affect the education and means of subsistence of perhaps hundreds of thousands of men. They possess great importance and deserve attention, just as injurious patent medicines concocted by quacks possess importance and deserve attention.

To write a good textbook of any kind is exceedingly difficult. To write a good elementary textbook for beginners is so difficult that the number of such books we have can perhaps be counted on the fingers. It is not true that if a man knows a subject he is competent to teach it or to write on it. Especially is this the case with technical subjects; for our technical men are as a rule lacking in that general culture and scholarship without which a person, however well he may know his specialty, cannot write well. And when a man having but a smattering of the subject and no general education attempts so arduous and so delicate a task, the results cannot fail to be disastrous—disastrous literarily, scientifically and pedagogically, and disastrous likewise mentally and financially to buyers, who lose at the same time their money and their hope, and gain nothing.

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A classified "List of Periodical Publications Relating to Municipal Affairs," compiled by Mabel L. Conat, of the Detroit Public Library, fills 13 pages of "Special Libraries" for October, published by the Special Libraries Association, Indianapolis, Ind.

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A large industrial map of Pittsburgh and vicinity was recently completed by the Pittsburgh Development Commission under the direction of George H. Lehman, chief engineer of the Flood Commission and of the Lake Erie & Ohio River Ship Canal. The map is 6x4 ft., is printed in four colors and has a scale of 4 in. per mile. It is based on data furnished by the United States Geological Survey, but was compiled largely by original fieldwork. It shows not only all streets, parks, roads, railways and street-car lines, but also indicates every manufacturing plant which has railway connections.

## REVIEWS AND NOTES

### New Edition of Kent's Boilers

REVIEWED BY W. S. FINLAY, JR.*

STEAM-BOILER ECONOMY: A Treatise on the Theory and Practice of Fuel Economy in the Operation of Steam Boilers—By William Kent, author of the "Mechanical Engineer's Pocket-Book." Second edition, revised and enlarged. New York: John Wiley & Sons, Inc. London: Chapman & Hall, Ltd. Cloth; 6x9 in.; pp. xvii + 717; 244 illustrations. $4.50, net.

In prefacing his second edition of "Steam-Boiler Economy," William Kent has briefly summarized certain particular points along which marked progress has been made in the science since the publication of the first edition in 1901. With these improvements as bases of discussion, much valuable matter has been added to the work, the development of fourteen years furnishing ample opportunities for revision.

Undoubtedly, so far as the college student is concerned, much will have been accomplished in supplying him with the essentials of that generally neglected end of the modern power plant, and if studied with sufficient care and vigorously applied in practical ways, the book should carry the student into professional life with a very satisfactory foundation in this department of his work.

For the engineer in practice the book can be of value only in so far as it may supply him with a source of reference for everyday application to design or operation. With this as the controlling idea, the following comments are submitted:

Passing over a general but necessary introduction covering fundamentals, there has been given a fairly comprehensive analysis of the subject of fuels and combustion, followed by opportunities for application in tabulated data, which include abstracts of reports by the United States Geological Survey and the Bureau of Mines. This latter, with the matter upon coal fields and miscellaneous fuels, is naturally of value for general information and may be used for reference, as therein have been collected and reduced to a practical size the essentials of unwieldy reports.

Proceeding to the actual study of the working unit itself, in considering the grate and furnace, much matter that was contained in the first edition pertaining to systems and methods that are now practically obsolete has been retained, and from the very fact that so much space is given to them, an impression is conveyed that exaggerates their importance. Particular reference is had to flat grates and hand fires, whose value the author himself discounts in recording instances of their replacement by stokers to increase efficiency and capacity. Numerous examples of stokers and fuel-oil burners have been detailed, as also types of furnaces, the design of the latter being generally controlled by the stoker or burner installed.

The introduction of new material in the edition on boiler design has added greatly to the value of the work. In interpolating, however, much of this has had the

*Construction Engineer, Motive Power Department, Interborough Rapid Transit Co., 600 W. 59th St., New York City.

effect of breaking up the sequence and making unnecessary repetitions. Elements of boiler design have been added and are well handled in the short space allotted.

Appliances conducive to economy in the boiler room are also briefly summarized. The chapter on analysis of boiler troubles has been practically entirely retained from the first edition, and although the subject matter is elementary, still in the amount of importance given to grate surfaces, flat grates, etc., much of it is really out of date and replete with troubles not now generally met with.

The balance of the book, on boiler testing, etc., is practically standard and includes results of recent research work of value in pointing out the type of data obtained and the methods employed.

As a whole, the new edition, with intimate acquaintance, will hold the place of its predecessor as a source of reference to the worker. The value of the book would have been greater had the old matter been completely eliminated or revised and the work entirely rebuilt with a view to maintaining careful sequence in analysis and grouping. Such information as is given should relate only to the best present practice, at the same time directing attention to the trend of development in the science.

## Building and Maintaining Track

ELEMENTS OF RAILROAD TRACK AND CONSTRUCTION—By Winter L. Wilson, Professor of Railroad Engineering, Lehigh University. Second edition, revised and enlarged. New York: John Wiley & Sons, Inc. London: Chapman & Hall, Ltd. Cloth; 5x8 in.; pp. vi + 396; 210 illustrations. $2.50 net.

TRAMWAY TRACK CONSTRUCTION AND MAINTENANCE—By R. Bickerstaffe Holt, M. I. Mech. E., Highways and Permanent Way Engineer, City of Leeds. London: Tramway and Railway World Offices. New York: D. Van Nostrand Co. Cloth; 6x10 in.; pp. xv + 249; 150 illustrations. 10/6. $4.50 net.

The book by Professor Wilson gives a comprehensive but summarized review of track construction and maintenance. In this way a great number of subjects are dealt with briefly and generally, except that the matter relating to turnouts goes into formulas and mathematical analyses. With such summarized treatment there are necessarily many omissions, and the subjects are not always covered very clearly.

The "bridge" rail is defined as a rail supported on intermittent supports. In point of fact it is what in this country is more commonly called the U-rail. The name relates to its form of section, and the early bridge rails were carried on continuous stringers. It is said to date back to 1844, but this should be 1834. Under "creosoting" no mention is made of the full-cell and empty-cell systems of treatment. The location of gravity yards is said to depend on the topography, but in point of fact the topography is more often made to suit the requirements, and the largest gravity yard in existence is located in flat prairie country.

The chapter on railroad construction, which belongs logically at the beginning of the book instead of at the end, deals with field parties and their work, grades and profiles, cuts and fills, trestles and culverts. An extraordinary feature is the entire omission of anything relating to curves, either in railway construction or track work, except that a rule is given for widening gage on curves. There is no mention of the wear of rails on curves and the compensation of grades for curvature. The matter on organization of maintenance-of-way forces is not very clear. It seems to assume that the organization is the same on all roads, and the distinction between departmental and divisional organization is not explained. The index is decidedly weak.

The foregoing points are mentioned to indicate the limitations of the book. It does not qualify as a work of reference; but the author states that the aim is "to present a few of the fundamental principles in such manner that the inexperienced engineering student can form a general idea of the subject." It should serve this purpose very well, though it would seem that a smaller and cheaper book would suffice. The author considers that the larger books on the subject are not suitable for classroom work, but such works are used in this way with satisfactory results. However, the student may gather a good general idea of railway work, and a little practical experience will soon extend his knowledge and modify his impressions on various points.

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The book on "Tramway Track" deals, as its name implies, with foreign (and mainly British) practice. The use of a concrete base is almost universal, but in many cases it has caused trouble because of insufficient strength and improper construction. Hand mixing only is referred to, and this method is probably the cause of much of the defective concrete mentioned. It seems strange that in these days such large jobs of concreting should be handled in this way.

Track is shown with and without cross-ties. Grooved rails only are considered, including the Romapac rail with renewable head. Mention is made, however, of a T-rail and guard-rail construction in Amsterdam, Holland, which requires four rails for each track. A curious feature in construction is that rails are laid usually with the base 1 to 2 in. above the concrete, the space being filled with stone chips (mixed with cement or pitch) or with longitudinal planks. There is danger of raising the rails while tamping this loose packing, and the author ascribes the majority of track-maintenance troubles to defective packing.

Considerable space is devoted to track-construction methods, including the welding of joints. The manufacture, wear and corrosion of rails are dealt with, but rail corrugation is not discussed, although machines for grinding corrugated rails are described. Curves, turnouts and special work are treated at some length. The paving materials considered are ordinary and smooth-dressed granite blocks and wood blocks.

An interesting feature of the book is the way in which the author points out the weaknesses and defects of some of the devices and methods described.

From a mechanical point of view the book is made unnecessarily bulky by the use of unusually large type, wide margins and waste spaces. In this respect it compares unfavorably with Professor Wilson's book, previously mentioned. The latter is lighter (little more than half the weight), smaller and handier, although it contains much more matter and is printed in large, clear type.

MANUAL OF SURVEYING FOR FIELD AND OFFICE—By Raymond E. Davis, C. E., Instructor in Civil Engineering, University of Illinois. New York and London: McGraw-Hill Book Co., Inc. Leather; 4x7 in.; pp. xv+395; 54 text illustrations. $2.50, net.

Like many similar surveying manuals by college instructors, this one is designed primarily for the use of college students. It is more practical than some others; among points emphasizing this are considerable informa-

tion on the precision of measurements and statements of the errors allowed in practice, methods of checking, some very useful tables and an excellent index. In fact, it has much more of the surveyor's fieldbook make-up than of the lecture-form notes for specific elementary problems, which is quite characteristic of some other works of similar nature.

## Engineering Thermodynamics

REVIEWED BY C. R. RICHARDS*

A TEXTBOOK OF ENGINEERING THERMODYNAMICS—By Charles Edward Lucke, Professor of Mechanical Engineering, Columbia University, and John J. Flather, Professor of Mechanical Engineering, University of Minnesota. An Abridgment of "Engineering Thermodynamics," by Charles Edward Lucke. New York: McGraw-Hill Book Co., Inc. Cloth, 6x9 in.; pp. xxiv + 688; 189 illustrations. $5, net.

HANDBOOK OF THERMODYNAMICS TABLES AND DIAGRAMS. A Selection of Tables and Diagrams from "Engineering Thermodynamics," by Charles Edward Lucke. Arranged and Amplified by John J. Flather. Cloth, 6x9 in.; pp. xvi + 238; 82 charts. $1.50, net.

These two books are made up from Lucke's "Engineering Thermodynamics," reviewed by the writer in *Engineering News* for Sept. 18, 1913. The first of these volumes contains the text and the second the various tables and charts from the original book.

While the textbook is styled an abridgment of the earlier work on "Engineering Thermodynamics," a rather careful comparison of the two volumes fails to disclose any radical changes in the subject-matter presented. In some of the chapters the original text has been slightly abridged, but the omissions are unimportant and do not seriously impair the usefulness of the book for general reference or for use in the classroom. The reduction in the number of pages in the new, as compared with the older, volume has resulted largely through a decrease in the size of the cuts used and a more compact setting of the numerous formulas presented.

The original volume is divided into three parts containing six chapters. The new volume retains the three major divisions, but the number of chapters is increased to nineteen, an arrangement which will doubtless commend itself to the teacher.

The handbook of tables and charts will be a valuable addition to the reference library of every engineer, whether for use with or without the text, for it contains a large amount of information which is not generally accessible, together with many graphical charts for the solution of problems in engineering involving thermodynamics.

TRATTATO DI COSTRUZIONI ANTISISMICHE. Preceduto da un Corso di Sismologia—By F. Masciari-Genoese. Milan, Italy: Ulrico Hoepli, Editore Libraio Della Real Casa. Paper; 7x10 in.; pp. xxviii + 1,004; 900 text figures. 24 Lire.

Earthquake-proof construction is already of wide interest, and is bound to have still wider spread. However, very little is known about the subject. That a 1,000-page treatise under the title "Earthquake-Proof Structures" should take an important place in our literature would be quite natural under these circumstances. But the book under review is a complete disappointment. What it contains of practical interest is found in about 100 pages, in the second half, where are described methods of building walls, foundations and a few other structural elements in such a way as to offer greatest resistance to earthquake destruction. Even this treatment is of little direct value because of its *ex cathedra* presentation of certain methods or details, without stating which constructions have been used in practice and which have given good or bad results. The publisher has provided at the end of the book two ruled blank pages headed "Annotazioni," perhaps anticipating the reader's desire to add information to the scant amount given by the author.

*Professor of Mechanical Engineering, University of Illinois, Urbana, Ill.

## Heating and Ventilating

HEATING AND VENTILATING BUILDINGS: A Manual for Heating Engineers and Architects—By Rolla C. Carpenter, M. Am. Soc. M. E., Professor of Experimental Engineering, Cornell University. Sixth edition, revised and rewritten. New York: John Wiley & Sons, Inc. London: Chapman & Hall, Ltd. Cloth; 6x9 in.; pp. xiv + 598; 290 illustrations. $3.50, net.

Carpenter's treatise long ago won a position as a leading manual for the layout and installation of heating and ventilating systems, but the "revision and enlargement" (which in the book trade is different from "revision and rewriting") which has marked each of the previous editions has not and obviously could not have kept the book thoroughly modern in all details for over 20 yr. The present extensive rewriting and rearrangement gives the text a new lease of life and very largely restores it to its old usefulness.

That does not mean that the revision has been thoroughgoing all through, for a careful reading of the book and comparisons with earlier editions show many lapses in the sections of minor importance to designers. For instance, the chapter on electrical heating remains largely as it was in 1902, both as to cited facts and data. Now at least some mention of the significant installations made in recent years in some Western irrigation power districts would be worth while. The most amusing failure to modernize the text is on page 241, where statistics on boiler explosions *up to 1893* are tabulated. In view of the painstaking studies of insurance companies and power journals, this is inexcusable. There are numerous other failures to bring the book up to date, but fortunately they relate to comparatively minor points so far as detail design is concerned.

There has been considerable condensation of various sections in order to provide space for new material. As a result the book is about the same size as the more recent reprints, though twice as large as the earlier edition. A very extensive rearrangement is seen. Some topics are grouped by complete systems instead of common parts. For instance, there are chapters on the design of gravity-steam, pumped-return and hot-water systems, containing what was before scattered under piping and design. This leaves the chapters on pipes and fittings, radiators and boilers largely descriptive. Revision in a reverse direction is seen where the subjects coming under flow of fluids are now bunched instead of being discussed separately in sections on water, steam and air.

The book starts out with a discussion of the nature and properties of heat, principles of ventilation and the amount of heat required for comfort. The heat given off by radiating surfaces and the flow of fluids are the subjects of intermediate chapters before the descriptions of apparatus are presented. The latter include the chapters on pipe and fittings, radiators, boilers, fittings and appliances, etc. After this are given the general layout and the detailed proportioning of parts for various steam-heating systems. A section on mechanical ventilators is logically introduced before hot-blast work is taken up.

The latter part of the book deals with electric heating, automatic temperature regulators and the special problems of schoolhouses, shops and greenhouses. Appended to all this are contract and specification suggestions, state laws on heating and ventilating and air conditioning. There is a bibliography extending from 1815 to 1895. An attempt has been made to bring the latter up to date by appending eight titles from 1902 to 1915. There are tables of standard weights and measures, pressure conversion, properties of gases, mathematical quantities (mensuration), logarithms, strength of materials, properties of air, relative humidities, properties of saturated steam, calorific value of fuels, etc.

## Mechanical Drawing

REVIEWED BY CHARLES W. REINHARDT*

MECHANICAL DRAWING FOR COLLEGES AND UNIVERSITIES—By James D. Phillips, Professor of Drawing and Dean of the College of Engineering, and Herbert D. Orth, Instructor in Drawing in the University of Wisconsin. Chicago and New York: Scott, Foresman & Co. Cloth; 6x9 in.; pp. 283; 295 illustrations. $1.75 net.

This volume is for use in university classes and is complete in itself. It cannot be said that the authors have slighted their subjects in any particular, as in some instances it appears that self-evident details of instruction have been presented at too great length. However, the book as a whole is well arranged and illustrated.

The illustrations present a pleasing departure from the prevalent style of "wax-engravings." They are directly reproduced in facsimile from well-executed originals. Quite a number of freehand sketches illustrate certain positions of the hands and principles involved. A mild protest might perhaps be made against the excessive finish and shading represented in Figs. 158 and 161.

The chapter on "Lettering" illustrates in considerable detail on about 50 separate practice plates the principles of the upright and inclined one-stroke style of Gothic lettering which for the past 20 years has almost universally been adopted.

A uniquely arranged Table of Contents, or "Outline," is one of the features of the volume. The book is ably written, with subjects attractively presented, and the general make-up is a model of neatness.

MASONRY AS APPLIED TO CIVIL ENGINEERING: Being a Practical Treatise on the Design and Construction of Engineering Works in Stone and Heavy Concrete—Adapted for the Use of Students and Those Engaged in the Practice of the Profession by F. Noel Taylor, author of "A Manual of Civil-Engineering Practice." New York: D. Van Nostrand Co. Cloth; 6x9 in.; pp. xi + 230; 212 illustrations.

In brief and fairly clear terms this book gives the details of the British practice in masonry construction. It is local in its application and can benefit an American engineer only in so far as it may show him some new way of performing a fairly familiar act. The wonder is that the practices in the two countries, which at one time must have been precisely alike, should have grown so far apart.

YEARBOOK OF THE UNITED STATES DEPARTMENT OF AGRICULTURE, 1914. Washington, D. C. Cloth; 6x9 in.; pp. 715; illustrated.

Among the articles of interest to engineers in this well-known annual publication are the following: Clean Water and How to Get It on the Farm; Retail Public Markets; State Management of Public Roads; The Economy of Farm Drainage; the Preparation of Fertilizer from Municipal Waste. The author of the last-named article sees little hope of recovering fertilizing material from sewage and urges the adoption of garbage-reduction processes instead of incineration, in order that the valuable material contained in the garbage may not be entirely lost.

## Factory Power-Plant Practice

PREVENTING LOSSES IN FACTORY POWER PLANTS—By David Moffat Myers. New York: The Engineering Magazine Co. (Works Management Library.) Cloth; 5x8 in.; pp. xvi + 560; 68 illustrations. $3.

Mr. Myers discusses modern power-plant practice, particularly for owners and managers of industrial works. This has necessitated a somewhat dilute treatment of matters which mechanical engineers are apt to review very concisely. It also results in emphasis on the accuracy with which today we may study energy phenomena.

After introductory remarks, the thermal losses in a boiler and engine plant are shown by a typical steam-balance sheet. This, with a pictorial diagram, gives an illustration of the cycle through which steam passes in a factory plant.

The next large step, and the one which leads to the real purpose of the book, is the presentation of a general plan for investigating the economy of a factory power system. This gives a list of the important items of information which will be disclosed by tests on the boiler plant, steam piping, engines and heating system. Four succeeding chapters take up in detail the path of an engineer-investigator in each of these divisions of a plant. Naturally, no attempt has been made to teach the plant owner to be his own expert—the aim seems to be rather to inform him as to what he may expect to have shown him, to a greater or less degree, by a properly qualified man.

One of the most important chapters in the whole book is entitled "The Human Factor." Here are disclosed the vast amount of fuel which can be wasted by improper firing of the boilers and the great advantages and economy that result through cutting down the working hours to a reasonable time, ventilating the boiler rooms, making the wages depend in part on eliminating waste of fuel, and from educating the men in regard to the economies which are possible. This chapter also has appended to it a plea for greater attention to safety in the engine and boiler rooms. Some of the more important safety devices and methods which have been installed are noted.

The following chapter describes systems installed by the author for increasing the efficiency of boiler plants, for finding what the efficiency actually is and for rewarding the employees. The rest of the book consists in what are virtually a series of appendices on subjects of interest to the works owner. First of these is a discussion of boiler tests as made by engineers today. The second takes up combustion reactions and losses. A third one presents the so-called "surface combustion" developed by Professor Bone in England and Professor Lucke in this country, involving flameless combustion of gaseous fuels and high-efficiency high-capacity absorption apparatus. A short chapter on natural gas tells what results may be expected with its use in different kinds of plants. One of the most interesting sections of the book is that on waste fuels—showing what has been accomplished in utilizing wood waste, tan bark, sugar-cane refuse, anthracite culm, etc.

*Reinhardt-Winters-Cahill Co., technical illustrators, Times Building, New York City.

A few pages give descriptions of such new types of prime movers as the "Locomobile," the "Unaflow" engine, and the Diesel motor. At the end of the book a couple of reports, made by the author to power-plant owners, on the improvement of their systems are reprinted as showing the typical form and substance of such investigations.

## Conquest of Yellow Fever at Havana and Panama

SANITATION IN PANAMA—By William Crawford Gorgas, Chief Sanitary Officer, Panama Canal; Surgeon General, U. S. A.; Major General, U. S. A. New York and London: D. Appleton & Co. Cloth; 5x8 in.; pp. 298; illustrated. $2, net.

The first half of this interesting and inspiring book is devoted almost wholly to yellow fever and its conquest, with particular reference to experiments and practices at Havana. The second half deals chiefly with the conquest of yellow fever at Panama. There is also something about the suppression of malaria at Havana, more about the control of that disease at Panama, and all through the volume the mosquitos—stegomyia and anopheles—that spread yellow fever and malaria receive due attention. In the half of the volume dealing with Panama there are chapters on measures against plague, leprosy, the hospitals, a sanitarium, the quarantine system and the sanitary department, all under the direction of the author.

As may be inferred from the foregoing remarks, the volume is first and chiefly a popular account of the discovery of the causes of yellow fever and of the utilization of that discovery by Colonel Gorgas to rid Havana and Panama of the disease. The title is very misleading, both because so much of the book has nothing to do with Panama and because only a part of the sanitary work at Panama is more than barely mentioned. The style is rambling—interestingly so; there is considerable but no tiresome repetition, and those who wish details of how Colonel Gorgas accomplished such marvels in Cuba and on the Isthmus must pick them up here and there as they lie scattered through the narrative. Nevertheless, the book is one to be thankful for. It doubtless fulfills the exact object of the author and will be read by and inspire hundreds of people that would give scant or no attention to a more scientific account of what Colonel Gorgas and others did to make the construction of the Canal possible without the needless sacrifice of a hundred thousand or more lives.

## Revised Edition of Hutte

"HUTTE"; DES INGENIEURS TASCHENBUCH—Herausgegeben vom Akademischen Verein Hütte, E. V. 22nd edition. (In Three Volumes.) Berlin: Wilhelm Ernst & Sohn. 5x8 in.; pp. 1,084, 1,077 and 1,109; 4,700 illustrations. Linen, 18 Marks; leather, 21 Marks.

Further improvement in many details, but no change in subdivision or treatment, marks the twenty-second edition of this widely used engineers' handbook. Following only four years after the previous edition, which represented extensive change, it is the more notable for being issued in the midst of war—the date of completed revision is April, 1915.

Among the revised or rewritten sections are those on measuring instruments used in testing, materials of construction, steam turbines, pumps, blowers, shipbuilding, foundations, reinforced concrete, railways and bridges. The new edition is thus considerably more than a mere reissue. With the changes goes an increase in number of pages. Each of the three volumes now is as bulky as the single volume which 10 or a dozen years ago formed the entire handbook.

Continuing the innovation made in the last edition, Vol. III is so planned as to cover all subjects of civil-engineering practice. It is thus adapted for separate use. The revision concerned itself particularly with this volume.

## Study of Ore Dressing

REVIEWED BY F. W. TRAPHAGEN*

THE THEORY AND PRACTICE OF ORE DRESSING—By Edward S. Wiard, S. B., Member, Min. and Met. Soc. of America. First Edition. New York and London: McGraw-Hill Book Co, Inc. Cloth; 6x9 in.; pp. 426; 254 text illustrations. $4, net.

Mr. Wiard has made an important contribution to metallurgy—a field not very well covered by existing books, Dr. Richard's classic standing almost alone.

Using his extensive practice as a basis, Mr. Wiard has brought together an extremely valuable mass of material. This he has made the subject of analytical study and the conclusions reached have wide bearing on current practice. The theoretical considerations are well handled and the precautions suggested to operators, with accompanying advice, will well repay careful reading. The book has a pleasing make-up and is comparatively free from typographical errors.

## Can Farmers Learn Surveying?

COMPASS SURVEYING AND THE SIMPLIFIED CALCULATION OF FARM AREAS—By Charles Mitchell Thomas, Civil Engineer and Surveyor. Wytheville, Va.: The Author. Cloth; 6x8 in.; pp. vi + 92; charts. $2.

The author has set himself an almost impossible task. As he describes it: "If you own a farm or if you are thinking of buying one, it will be a great source of satisfaction to you if you know how to calculate its area, so that you will not have to take another's word for it." He attempts to teach the real-estate agent and the farmer the familiar double-meridian-distance method of computing an area from a metes-and-bounds decription. This is a large order. He makes it more formidable by teaching also the principles and practice of compass surveying, with auxiliary remarks on magnetic declination and on adverse possession.

The most striking features of the text are the language and style employed. They represent the author's effort to fit his words and argument to the intelligence of his reader. Unusual similes and methods of explaining difficult conceptions abound, and so also does a rich Virginian vocabulary not lacking in charm.

*Engineering News* confesses itself unable to judge whether the book will succeed in instructing the farmer; and, what is more, it does not believe in making every man his own surveyor or engineer. But the book recommends itself unreservedly to every college teacher of surveying as a helpful and suggestive contribution to the art of teaching the subject to unprepared minds. Beyond this, there is sound sense in a remark contained in an advertising circular that reached us with the book: "If you happen not to be interested, give your boy or girl a chance; perhaps they can catch on to the calculation even quicker than you."

*Professor of Metallurgy and Ore Dressing, Colorado School of Mines, Golden, Colo.

A statement on page 26 may prove somewhat misleading. The author says: "When there is no fence on the line to be surveyed, and one corner can't be seen from another, a deed giving metes and bounds of the tract is required." This statement may be considered in several different ways; but in any event the reader should be acquainted more fully with the fact that a deed of the kind described may be useful even when one corner can be seen from another.

## Power and Heating Plants

POWER HEATING AND VENTILATION: A Treatise for Designing and Constructing Engineers, Architects and Students. (In Three Parts, Each Complete in Itself)—By Charles L. Hubbard, Consulting Engineer. Part III, Combined Power and Heating Plants. New York and London: McGraw-Hill Book Co., Inc. Cloth; 6x9 in.; pp. x + 408; 220 illustrations. $3, net.

The third volume of the new edition of Hubbard's "Power, Heating and Ventilation" series is now in hand, completing the set. The high standards of the previous volumes are maintained—even exceeded. As already noted (Feb. 11, 1915) the preceding volumes cover elementary heat phenomena, use of fuels, design and construction of boilers, furnaces, engines, etc., elementary theory of heating systems, design of heating equipment and estimates for heat losses from structures.

A large part of the present text is also given to boilers, engines, turbines, auxiliaries, piping, etc., and at first examination it might be thought to go back over the ground of the first two volumes. Careful comparison, however, shows that it deals with the proper selection and installation of such machinery rather than the design and construction of the individual pieces themselves, as is done in the earlier volumes. This book therefore supplements rather than duplicates its fellows. The arrangement follows a logical sequence of plant design, and indeed is a guide manual of combined power- and heating-plant design for special buildings.

Some of the minor shortcomings of the earlier volumes noted have been corrected in this text. Style has been kept clear, and the statements and data are definite. Little more could be asked. This volume, involving a departure from the scope of the original Hubbard treatise, is to be considered a first edition, and it is so marked.

The book starts out by describing the heating and ventilating schemes found in office buildings, theaters, banks, department stores, courthouses and other public buildings, hotels, hospitals, shops and mills. Practice is described concisely over a great range of structures. The author in his previous volumes has shown his ability to make original constructive suggestions for the improvement of inherited practice, and it is to be regretted that he did not turn his attention to that end upon some fields where complaint is rife. The opportunity exists notably in theater ventilation, where it is common to supply air under the chairs and to draw it out overhead, the street dust and smell immediately contaminating the fresh supply.

There are chapters on steam and hot-water heating and hot-blast heating and ventilating. This part of the book gives a notable collection of data on practice. So far, as will be realized from these remarks, the text is devoted to special heating and ventilating. Nearly 40% of the volume is thus passed through before combined heating and power plants are arrived at. In the rest of the book practice in central-station steam- and hot-water distributing systems is described. The combined power and heating requirements of the special buildings already enumerated are reviewed and summarized in tabular form.

PRACTICAL TRACK WORK—By Kenneth L. Van Auken. Chicago, Ill.: Railway Educational Press, 14 East Jackson Boulevard. Cloth; 5x8 in.; pp. 216; illustrated. $1.50.

Track work and the tool equipment required are dealt with here, but the book does not cover the design of track material or the work of maintenance-of-way. It begins with organization and equipment of the section forces, and then takes up tracklaying, double-tracking and relaying track. Curves, switch work, surfacing and general work on the track complete this portion of the book, covering 150 pages. The balance includes tables of useful information and a 36-page glossary of track terms. The book is written for the section foreman and sectionman. It will be useful also to the young engineer commencing his practical experience in the track department, although he will need other books to inform him as to the engineering features of track and maintenance-of-way.

AMERICAN SCHOOL BUILDING STANDARDS—By Wilbur T. Mills, Architect. Columbus, Ohio: Franklin Educational Publishing Co. Second edition. Flexible leather; 5x8 in.; pp. 616; illustrated. $5.

This is largely a compilation from various sources "modified by conclusions as experience and the most recent authorities approve." There is an introductory chapter on selecting an architect for public-school design, which contains information on architectural competitions and how they should be carried out. Other chapters present the general character of the building, cost of school buildings, ventilation, and a valuable collection of laws in the various states governing plan, construction, fire protection, sanitation and furnishings of public-school buildings. About half the book is a collection of typical floor plans and halftone engravings of recent school architecture.

The latest engineering society to establish a monthly publication is the Civil Engineers' Society of St. Paul, which issued the *Bulletin* for the first time in November. P. H. Sackett is editor pro tem.

An extended study of "Rainfall in New England," including a large collection of statistics of rainfall for places in New England and southeastern New York, fills 202 pages of the *Journal* of the New England Water Works Association for September, 1915. (Tremont Temple, Boston, Mass., $1 a number.)

A valuation of the property of the Queens County Water Co. (Borough of Queens) for the purpose of adjusting water rates is the subject of an interesting report of 177 pages made by Delos F. Wilcox, Deputy Commissioner of the Department of Water-Supply, Gas and Electricity, New York City.

One of the most interesting commercial pamphlets issued in recent months is Bulletin 13E of the engineering department of the National Lamp Works (General Electric Co.), "Multiple Mazda Lamps." The present types of tungsten-filament lamps for 105- to 125- and 220- to 250-volt circuits are described. The notes on operat-

ing characteristics, color quality, temperatures, efficiencies, use, etc., will be found intelligible to any engineer. New gas-filled types are briefly presented.

## NEW PUBLICATIONS

[So far as possible the name of each publisher of books or pamphlets listed in these columns is given in each entry. If the book or pamphlet is for sale and the price is known by the editor, the price is stated in each entry. Where no price is given it does not necessarily follow that the book or pamphlet can be obtained without cost. Many, but not all, of the pamphlets, however, can be secured without cost, at least by inclosing postage. Persons who are in doubt as to the means to be pursued to obtain copies of the publications listed in these columns should apply for information to the stated publisher, or in case of books or papers privately printed, then to the author or other person indicated in the notice.]

AGRICULTURAL DRAWING AND THE DESIGN OF FARM STRUCTURES—By Thomas E. French, Professor of Engineering Drawing, and Frederick W. Ives, Assistant Professor of Agricultural Engineering, in the Ohio State University. New York: McGraw-Hill Book Co., Inc. Cloth; 8x11 in.; pp. viii + 130; 182 illustrations. $1.25 net.

AIR BRAKES: References to Books and Magazine Articles—Pittsburgh, Penn.: Carnegie Library. [Reprinted from the Monthly Bulletin, July, 1915.] Paper; 6x9 in.; pp. 55.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS—Transactions, Vol. VII. New York: D. Van Nostrand Co. Cloth; 6x9 in.; pp. 308; illustrated. $3 net.

ECONOMIC CYCLES: THEIR LAW AND CAUSE—By Henry Ludwell Moore, Professor of Political Economy in Columbia University. New York: The Macmillan Co. Cloth; 6x9 in.; pp. viii + 149; 27 illustrations. $2.

THE ELASTICITY AND RESISTANCE OF THE MATERIALS OF ENGINEERING—By William H. Burr, M. Am. Soc. C. E., Professor of Civil Engineering in Columbia University. Seventh edition, thoroughly revised. Cloth; 6x9 in.; pp. xix + 928; illustrated. $5.50 net.

ELEMENTS OF HIGHWAY ENGINEERING—By Arthur H. Blanchard, M. Am. Soc. C. E., Professor in charge of the Graduate Course in Highway Engineering in Columbia University. New York: John Wiley & Sons, Inc. Cloth; 6x9 in.; pp. xii + 514; 202 illustrations. $2.50 net.

THE ELEMENTS OF MECHANICS OF MATERIALS: A Text for Students in Engineering Courses—By C. E. Houghton, Associate Professor of Mechanical Engineering in New York University. Second edition, revised and enlarged. New York: D. Van Nostrand Co. Cloth; 6x9 in.; pp. viii + 216; illustrated. $2 net.

ENGINEERING GEOLOGY—By Heinrich Ries, Professor of Economic Geology in Cornell University, and Thomas L. Watson, Professor of Economic Geology in the University of Virginia and State Geologist of Virginia. Second edition, enlarged. New York: John Wiley & Sons, Inc. Cloth; 6x9 in.; pp. xxvii + 722; 249 text illustrations and 104 plates. $4 net.

THE EXPERIENCE GRADING AND RATING SCHEDULE. Designed to Be a United States Standard for Measuring Fire-Insurance Costs Based Upon Combined Experience Averages—By E. G. Richards. To which is added by permission the "Standard Classification of Occupancy Hazards and Loss Report Form" of the National Board of Fire Underwriters. New York (76 William St.): The Board. Cloth; 6x9 in.; pp. 104.

GENERAL SPECIFICATIONS FOR CONCRETE WORK as Applied to Building Construction—By Wilbur J. Watson, M. Am. Soc. C. E. Second edition. New York: McGraw-Hill Book Co., Inc. Paper; 8x11 in.; pp. 56; illustrated. $1 net.

GUIDE TO THE REPORTS, EVIDENCE AND APPENDICES OF THE ROYAL COMMISSION ON SEWAGE DISPOSAL (of England)—By G. Bertram Kershaw, M. Am. Soc. C. E., Engineer to the Commission. New York: D. Van Nostrand Co. Cloth; 6x9 in.; pp. 178. $2 net.

A table of contents of the ten reports in 30 volumes, together with separate indexes of names, places and subjects of the present volume. The Guide promises to be a time saver to those having occasion to refer to the various reports of the commission.

HOW TO MAKE LOW-PRESSURE TRANSFORMERS—By F. E. Austin. Second edition, with additions. Hanover, N. H. (Box 441): The Author. Linen; 5x7 in.; pp. 17; 4 illustrations. 40c.

INVENTORS AND MONEY-MAKERS: Lectures on Some Relations Between Economics and Psychology Delivered at Brown University in Connection with the Celebration of the 150th Anniversary of the Foundation of the University—By F. W. Taussig, Henry Lee Professor of Economics in Harvard University. New York: The Macmillan Co. Cloth; 5x8 in.; pp. ix + 135. $1.

IOWA STATE HIGHWAY COMMISSION—First Annual Report, 1913-1914. Ames, Iowa: The Commission. Cloth; 6x9 in.; pp. 351; illustrated.

JAHRBUCH DER TECHNISCHEN ZEITSCHRIFTEN-LITERATUR, Ausgabe, 1915 — Herausgegeben von Heinrich Rieser. Vienna, Austria: Verlag für Fachliteratur, Gesellschaft m.b. H. Paper; 6x9 in.; pp. 98. 4 marks.

LEHRBUCH DER EISENHÜTTENKUNDE Verfasst für den Unterricht, den Betrieb und das Entwerfen von Eisenhüttenanlagen—By Bernhard Osann, Professor an der Königlichen Bergakademie in Clausthal. Erster Band, Roheisenerzeugung. Leipzig, Germany: Verlag von Wilhelm Engelmann. Paper; 7x10 in.; pp. xiii + 668; 407 illustrations, 17 tables. 29 marks. Bound in linen, 30.50 marks.

MACHINE DESIGN—By Albert W. Smith, Director of Sibley College, Cornell University, and Guido H. Marx, Professor of Machine Design, Leland Stanford Junior University. Fourth edition, revised and enlarged. New York: John Wiley & Sons, Inc. Cloth; 6x9 in.; pp. xii + 500; 278 illustrations, 31 tables. $3 net.

MUNICIPAL FREEDOM: A Study of the Commission Government—By Oswald Ryan, formerly of the Department of Government, Harvard University. With an Introduction by A. Lawrence Lowell, President of Harvard University. Garden City, N. Y.: Doubleday, Page & Co. [The American Books.] Cloth; 5x8 in.; pp. xvi + 233. 60c. net.

NOTES ON HEATING AND VENTILATION—By John R. Allen, M. Am. Soc. M. E., Professor of Mechanical Engineering in the University of Michigan. Third edition. Chicago, Ill.: Domestic Engineering Co. Cloth; 6x9 in.; pp. vi + 227; 84 illustrations. $2.50.

PLANE ANALYTIC GEOMETRY, With Introductory Chapters on Differential Calculus—By Maxime Böcher, Professor of Mathematics in Harvard University. New York: Henry Holt & Co. Cloth; 5x8 in.; pp. xiii + 235; 75 illustrations. $1.60.

PROCEEDINGS OF INTERNATIONAL IRRIGATION CONGRESS—Held at Calgary, Alta., Canada, Oct. 5-9, 1914. Spokane, Wash.: Arthur Hooker, Secretary. Paper; 6x9 in.; pp. 402; illustrated.

RAILWAY REGULATION: An Analysis of the Underlying Problems in Railway Economics from the Standpoint of Government Regulation—By I. Leo Sharfman, Professor of Political Economy, University of Michigan. Chicago: La Salle Extension University. Flexible leather; 6x9 in.; pp. vi + 230. $2 postpaid.

REGULATION OF RAILROADS AND PUBLIC UTILITIES IN WISCONSIN—By Fred L. Holmes. New York: D. Appleton & Co. Cloth; 6x9 in.; pp. xi + 375. $2 net.

RETURN AS TO WATER UNDERTAKINGS IN ENGLAND AND WALES—Local Government Board; H. C. Monro, Secretary. London: Wyman & Sons, Ltd.; T. Fisher Unwin's Foreign Agencies. Paper; 8x13 in.; pp. 599. 5/1.

RIVINGTON'S NOTES ON BUILDING CONSTRUCTION: A Book of Reference for Architects and Builders and a Textbook for Students (in two volumes)—Edited by W. Noble Twelvetrees. New edition, entirely rewritten. New York: Longmans, Green & Co. Cloth; 6x9 in. Part I, pp. 306; 484 illustrations. Part II, pp. 332; 395 illustrations. $2.25 each.

SAFETY IN STONE QUARRYING—By Oliver Bowles. Washington, D. C.: Superintendent of Documents. Technical Paper 111 of the Bureau of Mines. Paper; 6x9 in.; pp. 48; illustrated. 10c.

SIMPLIFIED REINFORCED-CONCRETE MATHEMATICS: Derivation of Simple, Universal Formulas and Application of Same to Beams, Columns and Arches with Nomographic Computing Device—By Melvin D. Casler, Assoc. M. Am. Soc. C. E. New York: D. Van Nostrand Co. Cloth; 5x8 in.; pp. vi + 66; illustrated. $1 net.

STEEL SHEET PILING: Tables and Data on the Properties and Uses of Sections Manufactured by the Carnegie Steel Co., Pittsburgh, Penn. Paper; 5x8 in.; pp. 96; illustrated.

A good little monograph, now in its tenth edition, well worth a place in every engineer's library. If it contains some points that appear doubtful or debatable, it need only be remembered that the subject of sheeting is rich in debatable matters, and the engineer is therefore likely to be prepared for differences of view.

THE THEORY OF MACHINES—By Robert F. McKay, Lecturer in Theory of Machines and Machine Design at the City and Guilds (Engineering) College, London. New York: Longmans, Green & Co. Cloth; 6x9 in.; pp. viii + 440; 407 text illustratons. $4.20 net.

UNITED STATES GEOLOGICAL SURVEY PUBLICATIONS—Washington, D. C. Paper; 6x9 in.; illustrated.

Water-Supply Papers—No. 340-L, Stream-Gaging Stations and Publications Relating to Water Resources, 1885-1913; Part XII, North Pacific Slope Drainage Basins. Compiled by B. D. Wood. Pp. 147-195. No. 371, Equipment for Current-Meter Gaging Stations. By G. J. Lyon. Pp. 64. No. 375-F, Conditions Requiring the Use of Automatic Gages in Obtaining Records of Stream Flow. By C. H. Pierce. Pp. 131-139.

Mineral Resources of the United States, 1914, Part II—No. 17, The Gypsum Industry in 1914. By G. F. Loughlin. Pp. 261-270. No. 28, Statistics of the Clay-Working Industries in the United States in 1914. By Jefferson Middleton. Pp. 455-548.

Bulletin No. 621A, Field Apparatus for Determining Ash in Coal. By C. E. Lesher. Pp. 12.

WHAT SCIENTIFIC MANAGEMENT MEANS TO AMERICA'S INDUSTRIAL POSITION—By Frank B. Gilbreth and Lillian Moller Gilbreth. [Reprinted from "The Annals" of the American Academy of Political and Social Science, Philadelphia, September, 1915, Publication No. 935.] Providence, R. I. (77 Brown St.): Frank B. Gilbreth. Paper; 7x10 in.; pp. 9.

WIRE-DRAG WORK ON THE ATLANTIC COAST—By N. H. Heck and J. H. Hawley, Assistants. Special Publication No. 29. Washington, D. C.: United States Coast and Geodetic Survey. Paper; 9x12 in.; pp. 24; 8 illustrations. 10c.

WIRELESS TELEGRAPHY—By Dr. J. Zenneck, Professor of Physics at the Technical High School of Munich. Translated from the German by A. E. Seelig. New York: McGraw-Hill Book Co., Inc. Cloth; 6x9 in.; pp. xx + 443; 469 illustrations. $4 net.

THE YEAR-BOOK OF WIRELESS TELEGRAPHY AND TELEPHONY, 1915—New York: The Marconi Publishing Corporation. Cloth; 6x9 in.; pp. 800; illustrated. $1.50.

# Field and Office

## Wire and Rock Mattress to Protect Bridge Pier

By J. H. Fisk*

In the spring of 1914 the north pier of a two-span steel highway bridge over the Grand River at a point about 12 mi. west of Grand Junction, Colo., was found to be undermined. The pier was one of the steel-tube type and rested on a concrete footing. Leaning against the pier was a rotted log structure built to protect the pier from the thrust of the rock and earth fill serving as an approach to the bridge. The depth of water at the base of the pier was 7 ft. and soundings showed that approximately one-half the area of the base of the concrete footing was unsupported, allowing the pier to lean against the bridge, a condition plainly shown by the buckling of the bottom chords of the north span.

Plans were hurriedly made by the writer to jack up the bridge and carry the footing of the pier down to a safe foundation. But on account of the shortness of the time before the spring rise, and also the rapid erosion of the river bank above the bridge, this idea was abandoned and plans were drawn for stopping the undermining of the pier and preventing the bank of the river from further erosion.

The river carries at this point from 3,000 sec.-ft. at low water to possibly 50,000 sec.-ft. at high water. The north bank was formed by a precipitous layer of sandy adobe about 8 ft. thick rising from a point 2 or 3 ft. above low water and underlain by a stratum of sand and gravel of unknown thickness, but exposed by the action of the water to an average depth of 7 ft. To secure permanent protection it was considered necessary to riprap the river bank for a distance of 750 ft., commencing at the pier and extending up the river to the mouth of a bayou entering at that point.

After rejecting numerous suggestions, including rock-filled log cribs, brush and pile forms of protection, it was decided to reduce the river bank to a slope of 1:1 and cover it with a mattress made of woven wire fencing and stone, carrying the outer toe of this mattress well into the deepest part of the river.

The specifications were intended to insure the use of stone that would not disintegrate in water and of such dimensions that it could not pass through the meshes of the wire, and covered the wire to be used, not specifying the particular make, but limiting the greatest dimensions of mesh and the least diameter of wire.

Under water the mattress was formed by laying stone-filled wire bags, 3 ft. in diameter, side by side and securely tied together, with their bottoms resting on the river bed at the deepest point and their tops coming out at the edge of the water far enough to permit of fastening to the portion of mattress laid on the bank above water. The mattress above water was 11 ft. wide and was formed by laying strips of wire fencing parallel with the river bank, commencing at the tops of the submerged sacks and wiring all strips securely together, with tie wires spaced not over 6 in. apart. Strips of fencing cut 18 in. wide were then set up vertically and wired transversely to those already laid, forming compartments 54 in. wide, 18 in. deep and 16 ft. long, which were then filled with stone. A covering of wire similar to that which formed the bottom of the compartments was then laid over the entire surface and securely wired to the transverse strips, the whole being firmly tied to the upper ends of the submerged sacks.

The placing of the sacks under water was accomplished by the use of light scaffolding which rested at point of deepest water, nowhere over 15 ft. from the bank.

The work was commenced at the lower end of the pier and carried upstream, a sack being sunk into place with tie wires attached and held temporarily by fastening to the scaffolding. When full, it was allowed to fall into place, the tie wires being slipped through the meshes of the next succeeding sack as it was lowered to its position.

Careful inspection, after the passage of two spring floods, has failed to disclose any sign of failure in the wire and the protection has successfully prevented any further erosion.

The work was done by contract in 13 days and required 1,200 cu.yd. of loose stone and 1,018 rods of woven-wire fencing 3 ft. wide. Suitable stone was found ½ mi. distant. The contract was awarded to the low bidder at $2,839, on which a fair profit was realized.

*Engineer, Arkansas Valley Irrigation Co., Dodge City, Kan.

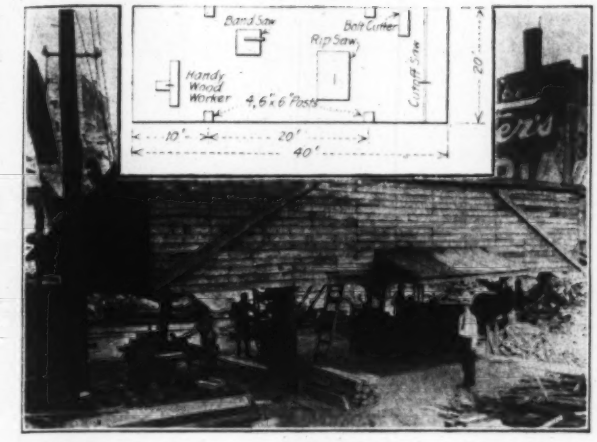
## Sawmill for Form Construction

By Harold E. Ketchum*

On large concrete construction an efficient sawmill is essential. The Detroit-Superior high-level bridge in Cleveland, a double-deck reinforced-concrete arch bridge 2,800 ft. long, requires a large amount of formwork. Cableways command the site of the bridge, so that forms of any size can be built at the mill and set in place. The sawmill was designed to allow the greatest freedom in handling lumber through the various saws.

The roof is supported on four 6x6 posts, there being no walls or other obstructions. The posts are placed 10 ft. from the corners of the building, the ends of the roof being carried as cantilevers and the center trussed with light bracing. The sawmill itself is 20x40 ft. in plan, with a plank floor level with the surrounding ground. The following machines are being used: An 18-in. swing cutoff saw, a 16-in. ripsaw, a 36-in. bandsaw, a bolt-threading machine and a handy woodworker. The latter, a boring and saw tool operated by an individual motor on the upper part of the frame of the machine, with 12-in. saw, has proved accurate and economical, especially on light cutoff work. The other machines are driven through belts and countershafts by a 15-hp. alternating-current motor placed 8 ft. above the floor.

*Superintendent, Hunkin-Conkey Construction Co., Cleveland, Ohio.




SAWMILL FOR FORMS; DETROIT-SUPERIOR BRIDGE
Dimensions and machinery location

Lumber is received on cars and piled to the south of the mill. It passes north through the saws to benches, where the forms are assembled. The forms are placed north of the benches, directly under the cableways, and taken away as required.

The Detroit-Superior bridge is being built for Cuyahoga County, for which K. D. Cowen is resident engineer. The Hunkin-Conkey Construction Co. has the contract.

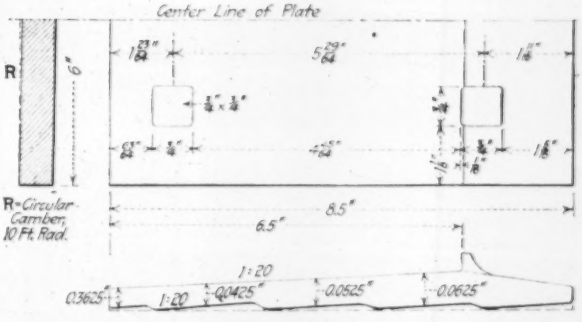
## Stone-Unloading Plant for Concrete-Road Contract

The two views show a plant for unloading broken stone from railway cars in use by the Williams & Little Co., general contractors, of Cleveland, Ohio, on a concrete-road contract near Perry, Ohio. Hopper-bottom cars bring the stone in on a main-line siding and dump it into the boot of a conveyor, which carries it to the bins. An oscillating plate in the pit insures the free flow of the stone to the buckets of the conveyor without the need of any hand shaking or scraping.

The bins are provided with two sets of chutes—one short set for feeding to wagons and one longer one for leading to the motor trucks which cannot get close to the framework. The trucks or carts take the stone as needed to the job.

## Tie-Plate with Inclined Face

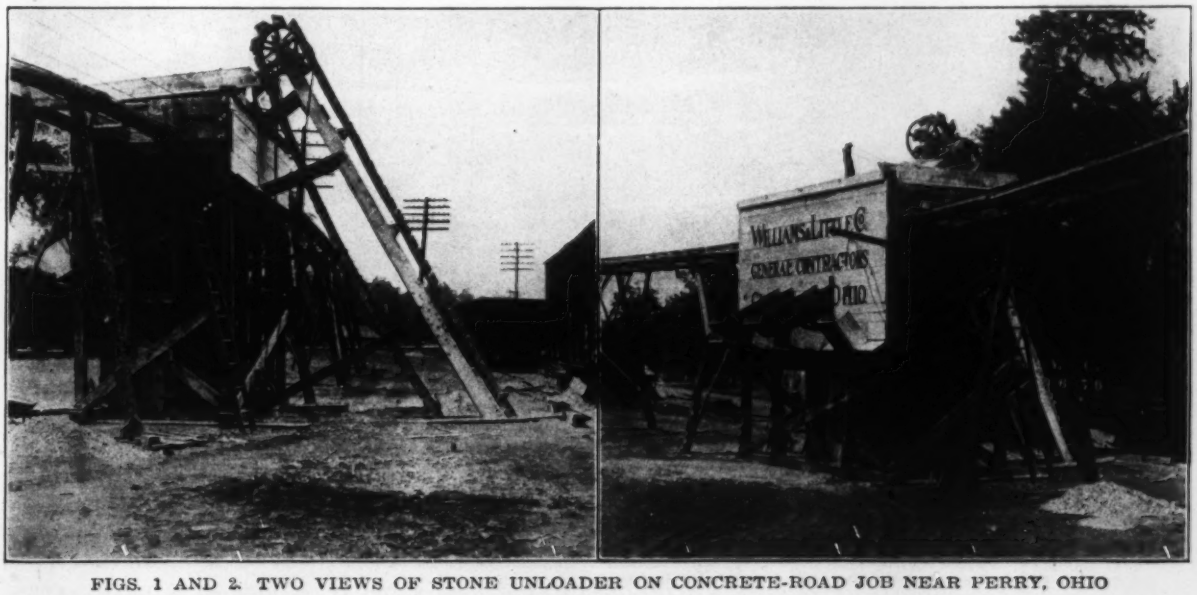
A tie-plate which gives the rail an inward inclination, so that it is practically at a right angle with the coned surface of the wheels, is being tried on several railways. The drawing shows the tie-plates as used on the New York, Ontario & Western Ry. It is 8½x6 in., with the bearing surface or rail seat inclined 1 in 20 and having a shoulder to engage the outer edge of the rail base. The




TIE-PLATE WITH INCLINED FACE; NEW YORK, ONTARIO & WESTERN RY.

bottom of the plate has the same slope, but is stepped to give an increasing thickness from the edge. Longitudinally with the rail the plate is given a circular camber of 10-ft. radius. There are four spike holes.

This inclining of the rail is general practice on foreign railways, but has not been given much attention in this country. It is claimed that it will give increased stability to the track, with a reduction in maintenance work. The tie-plate illustrated is the invention of John Lundie, 52 Broadway, New York, N. Y.




FIGS. 1 AND 2. TWO VIEWS OF STONE UNLOADER ON CONCRETE-ROAD JOB NEAR PERRY, OHIO

## Sinking Foundations Through Steel and Concrete

A 16-story loft building is being constructed on the site of the old Hoffman House and Albemarle Hotel, 24th St. and Broadway, New York City. The last extension of the Hoffman House, built only 10 yr. ago, was founded on concrete piers carried down to rock in open pits held by steel sheeting. This sheeting, of the Friestedt type, was cut off at grade by electric arc and left in the ground. Thus the ground is filled with concrete, steel grillage girders of the cantilever footings, and steel sheeting; since the new column locations do not match the old ones, the new piers have to be sunk through the miscellaneous materials mentioned. Naturally the work is tedious and expensive. The Thompson-Starrett Co., which built the extension, is also constructing the new building and is therefore in the position of cutting through its own substantial construction of 10 yr. ago.

In cutting out the concrete incasement of the grillage and cantilever girders the only tools used are bull points, mauls, sledges and wedges. The bull points are 1½-in. octagon steel. The slowest part of the work is chopping the concrete (or grout) out of the pockets, such as the space between pairs of girders where cement mortar had been poured in to fill the space. In such cases, after laying bare the outside of one of the girders the girder is cut through with oxygen flame (see view, Fig. 1, taken after complete removal of one girder section and interior concrete), wedged out to get it loose from the inside concrete as far as possible and then this inside concrete chopped out bit by bit with the bull points.

Some of the 48-in. plate girders which, set in pairs side by side, formed the main cantilever girders for the north wall footings are rather difficult objects to cut, because they have three web plates in the end section—a

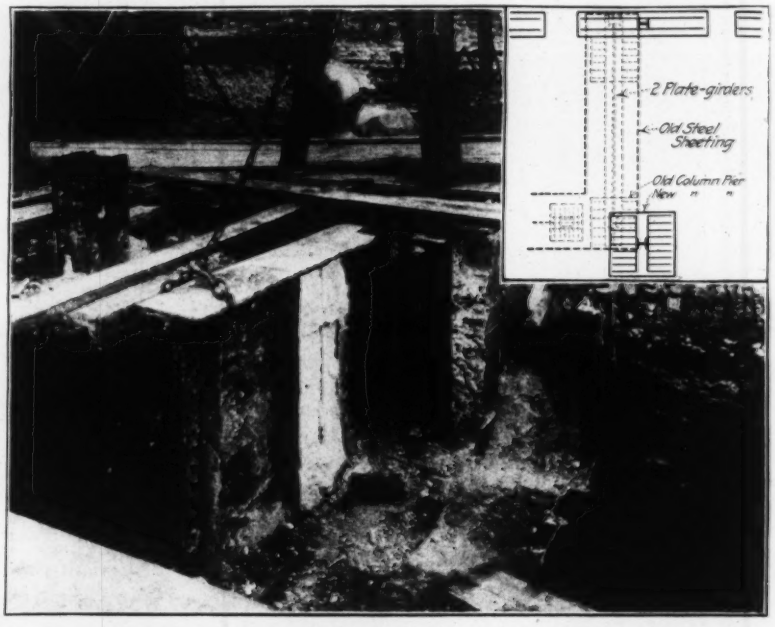



FIG. 1. CUTTING THROUGH CONCRETE-CASED PAIR OF PLATE GIRDERS IN OLD CANTILEVER FOOTING

The cut through triple web and flanges consumed about 125 cu.ft. Blaugas and 200 cu.ft oxygen

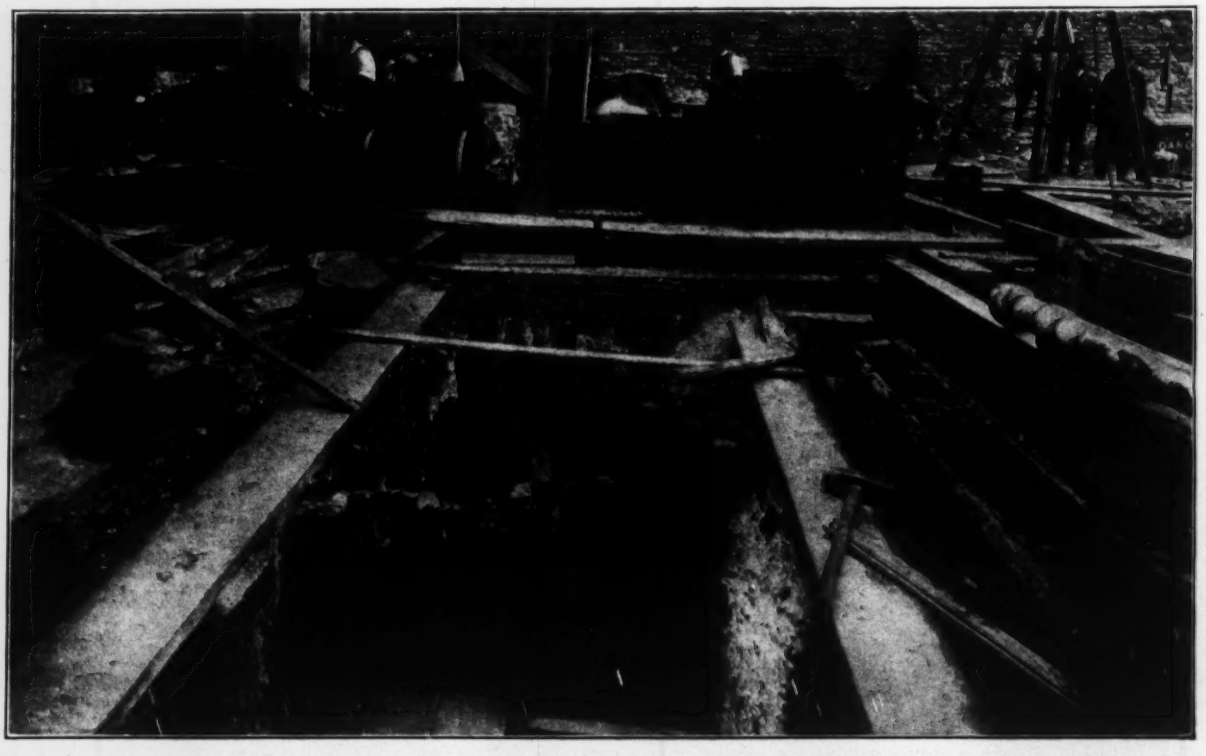


FIG. 2. OLD STEEL SHEETING, CONCRETE AND GIRDERS WHICH NEW FOUNDATION PITS MUST PENETRATE

regular central web plate and two reinforcing webs spaced about ¾ in. away from the central web. This cut (Fig. 1) required about 200 cu.ft. of oxygen and about 125 ft. of Blau gas. When the webs were cut through about a quart of water ran out, although the soil surrounding this footing is entirely dry and has been so for years. The water may have come from the combustion of the gas.

Wherever the old sheetpiling comes within the new foundation pits it is laid bare and cut out in sections. The torch will cut about 8 ft. per hour of the piling. At one point, where the piling was driven close on the outlines of the pier and the concrete fills it completely, the builders expect to leave in the old pier and sheeting and concrete around it for the remaining area of the new pier.

The new piers are being put down by open excavation, the pits being sheeted as soon as they get down low enough to require a platform. Rock is nowhere over 25 ft. below cellar bottom, and except for a few feet just over the rock the ground is dry.

A. G. Moulton is superintendent for the contractors.

## How Concrete Lamp-Posts Are Made for Lincoln Park

By George T. Donoghue*

Concrete lamp-posts are being used extensively on the boulevards of the Lincoln Park system in Chicago. They were first used in 1907. During the past year 133 were installed, making a total of 947 now in service. They were designed by John Hamilton, of the firm of Perkins, Fellows & Hamilton architects, of Chicago. The design is copyrighted.

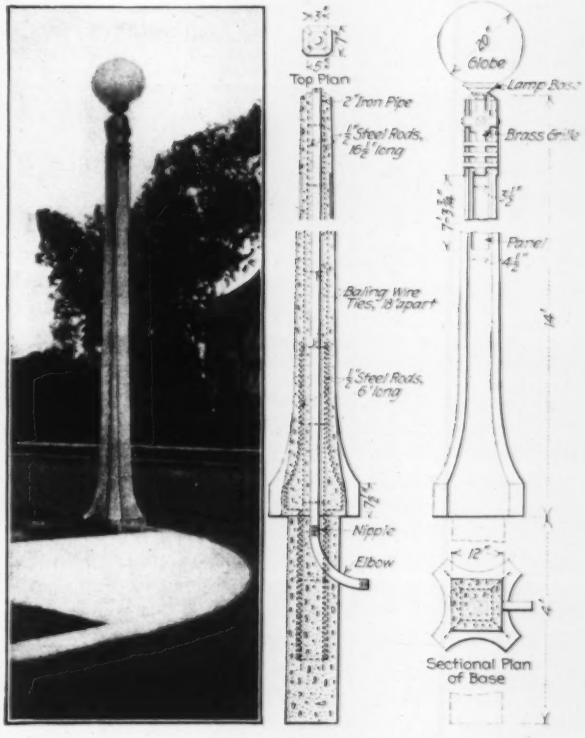
The body of the post is composed of very dry concrete—1 part cement, 1.5 parts torpedo sand and 2.5 parts of ½- to ¾-in. limestone. The surface dressing above ground consists of ½ in. of 1 : 1 : 1½ mortar composed of cement, torpedo sand and fine red granite screenings. To this mortar is added 5 lb. of mica for each post. The mold for the portion of the post above ground is of cast iron. It consists of a base and two sides and resembles a trough. This is bolted to a wooden form (also in the shape of a trough) for the portion of the post that is below the ground.

To prevent sticking, the mold is given a light coat of cheap machine oil before the concrete is put in. The bottom of the iron trough and about 2 in. on each side are coated with the surface mortar. Dry concrete to form the body of the post is then introduced and a reinforcing bar placed in each corner. The sides are then lined a little higher with mortar and more concrete is added. At the center a 2-in. cast-iron pipe is placed to carry the electric-light wires. The sides are again lined with mortar and the entire trough is almost filled with concrete, a reinforcing rod being placed in each upper corner.

The top is then covered with the surface mortar, leaving the mold a little more than full, the top or lid of the mold being then put on and bolted firmly into place. This forces the concrete into all lines and corners of the mold. The portion of the post below ground receives no surface dressing.

The post is allowed to remain in the mold 24 hr., after which the top and the sides are removed so that curing can proceed more rapidly. The bottom mold is usually removed after 48 hr., but sometimes it is necessary to wait 72 hr. Complete drying of a post takes about 120 hr.

When the post is completely dry the surface is quickly brushed with muriatic acid. This removes all the cement on the outer surface and gives an effect resembling natural granite. As soon as the post has been completely covered with acid it is drenched with water and brushed over with a broom to prevent the acid from attacking the cement in the body of the post. About 2 gal. of acid is used for each post. The posts when finished weigh 2,000 lb. The cost of manufacture varies from $16 to $19 each. Union cement finishers are used in doing this work. The posts are built under the direction of Philip Zimmer, master mechanic.



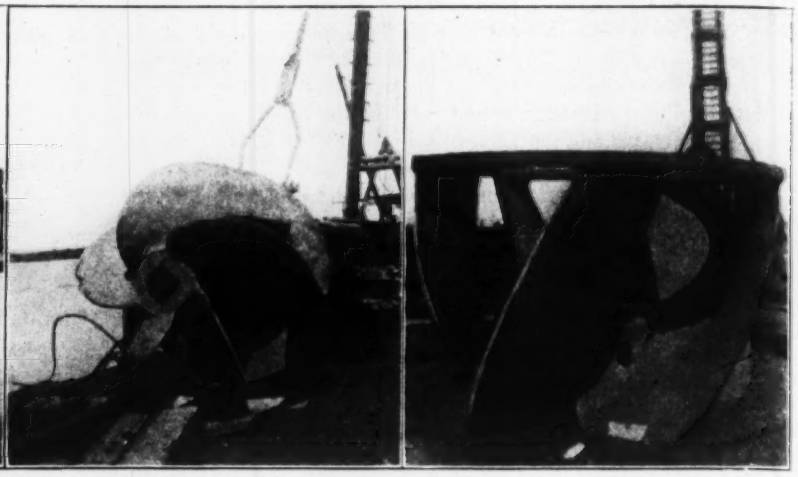

CONCRETE LAMP-POST OF THE LINCOLN PARK COMMISSION IN CHICAGO

In erecting these posts a hand-power derrick mounted upon a large wagon is used. The post is set in a prepared hole and concrete 12 in. thick is placed around the base.

*Chief Engineer, Commissioners of Lincoln Park, Chicago.

**Concrete "Atomizer" Repairs Brick Railway Tunnel Arch**—The Chicago Great Western Ry. tunnel at Winston, Ill., a 2,600-ft. single-track tunnel on 1% grade, showed serious destruction of the arch brickwork by water and locomotive exhaust. The lower layer of the arch and part of the second layer had been destroyed. The tunnel was very wet, and near the east end water flowed freely from the roof. The arch was repaired by H. P. Brown with the concrete "atomizer," which put on a surface layer of 1:3:2 concrete made with ½-in. gravel. Just ahead of the spray work, men with pneumatic hammers and a hose cleaned off the surface of the arch. The nozzle car, set behind the materials car in the work train, carried on two longitudinal rails a truck supporting the nozzle journaled to swing in a transverse plane, so that in one spotting of the train a 10-ft. length of arch could be covered. The sprayed concrete, applied in several layers, adhered perfectly, even where water was coming through the brickwork. The air pressure used here was 80 lb. A mechanically operated trowel arm was tried for finishing the surface, but it worked only where the track was in the center of the tunnel. High-pressure steam jetting gave a troweled effect.

FIG. 1. OLD CUTTER HEAD



FIGS. 2 AND 3. TWO VIEWS OF NEW CUTTER HEAD

## Special Cutter Head on Dredge Working in Hard Material

By J. H. Gandolfo*

In building the new coal-storage dock at San Juan, Porto Rico, for the Porto Rico Coal Co. it was necessary to excavate about 70,000 cu.yd. of material for the slip and channel approaches. For this purpose a suction dredge is in use, with a 50-ft. arm carrying the cutter head, a 12-in. centrifugal pump driven by a 200-hp. motor and 12-in. suction and discharge pipe. The first cutting head provided was fitted with six cast-iron blades, bolted to six arms radiating from the operating shaft, and had an extra set of manganese-steel blades.

All dredging is to be completed to a minimum depth of 24 ft. The top 10 ft. consisted of soft mud, full of manglaris roots, and the remainder is a tough yellow clay, alternating with patches of a tough white sand that has enough clay mixed with it to prevent it from disintegrating in the water. In addition, occasional pockets of a hard coral are encountered. Both the clay and sand become very hard on exposure to the air.

At the beginning of operations a cut for the full depth necessary was taken out, in order to test the equipment. It was soon realized that the cutter head at first provided would not be able to handle the hard material. On account of the arms supporting the blades and the closeness of the blades, the head was constantly blocked with both the clay and sand. Fig. 1 is a front view of the old cutter head clogged with material so hard and tenacious that to clear the head it was necessary to pry the material out with bars.

After several consultations, the contractors designed the cutter head shown in Figs. 2 and 3. It is 42 in. in diameter at the larger end, has five blades, with a supporting ring at the rear, and is carried at the front on a central shaft. The front end of this shaft may be noted in Fig. 3, which also shows the opening to the suction pipe between the blades. The head is of cast steel.

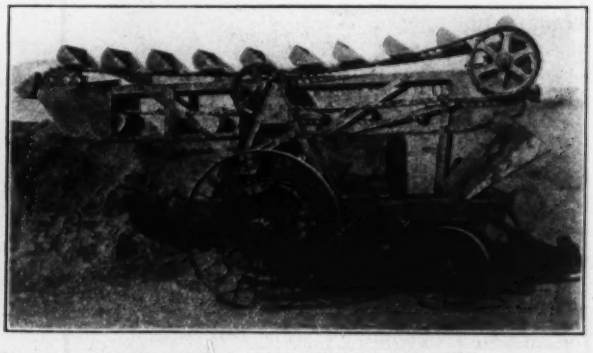
This cutter head has given entire satisfaction on the work. Because of the wide space between the blades leading to the suction pipe it rarely becomes clogged. It is also successful in breaking up the beds of coral small enough to pass through the discharge pipe.

The Moody Engineering Co., of New York, is the engineer for this work, and John Monks & Sons the contractor, with E. D. Buel as superintendent.

*Resident Engineer, Moody Engineering Co., San Juan, P. R.

## Wagon Loader Handles 10,000 Yd. of Traprock

The Park Department of New York City has been using a gasoline wagon loader for handling run-of-crusher traprock used in road repair. This machine, working pretty steadily throughout the summer at Van Cortlandt Park, loaded 10,000 yd. into horse-drawn wagons and tractor-trains.



GASOLINE WAGON LOADER HANDLING TRAP IN VAN CORTLANDT PARK, NEW YORK CITY

Left—Loading traprock into wagons. Right—Elevator raised in position for transportation, so as to clear gateways, trestles and wires

The gasoline engine of the loader is being rebuilt at the present time, this making its second thorough overhauling since purchase. The engine was 6 hp. and found to be rather light for such continuous heavy work. The Park Department, however, appears to be well satisfied with the performance of the machine and intends to put it to work on a 375,000-yd. pile of traprock just as soon as the engine is ready for service. This rock is situated below the Park reservoir and was intended for use in connection with a filter plant. When the filter project was abandoned the rock was turned over to the Park Department for road repair.

The wagon loader was built by the George Haiss Manufacturing Co., 141st St. and Rider Ave., New York City. It cost the Park Department $700 and weighed 4,250 lb. Except for the motive power, the machine is exactly the same as the electric loader manufactured by this company.

## Columns Over Clearways in Newark Terminal

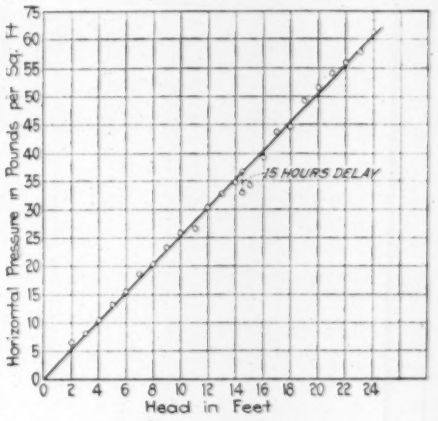
In the design of the Public Service Ry. terminal and office building in Newark, N. J., described in *Engineering News* of Oct. 28, 1915, it was necessary in two places to support two lines of columns over clear spaces. One of these was at the front, where a line came down over the subway leading from the building. Clearance was limited. Here a triple girder, spanning 36 ft. and weighing 33 tons, was used. Each of the three component girders has a 48x3/8-in. web and 8x6x5/16-in. flange angles. The outer webs have only outer flange angles, and 12x7/8-in. plates were used on the inner face to make up. Each flange of the composite girder has four 34-in. cover plates, totaling 3¼ in. in thickness, riveted to all four flange angles.

The second place where clear space was required was in the auditorium of the building. A Pratt truss in the 8-ft. roof space above the eighth story carries a line of hanger bars replacing the columns for four stories below. The design of this truss and the areas of end columns and hangers are shown in the accompanying sketch.

## Pressure of Cottonseed

By W. M. Eliot*

Some designers of cottonseed warehouses use the results of tests made on wheat, with a correction for the difference in weight of the two materials, to obtain the horizontal pressure. They cannot have much confidence in the results secured by this method, as the conditions are unlike in nearly every respect. The tests on wheat have usually been made in relatively deep bins; cottonseed is stored in shallow ones. The angle of repose of cottonseed varies, but any of it will stand at a much steeper slope than will wheat. Wheat will flow through an orifice under any appreciable head, while the seed will not. Wheat is stored just as it falls from the conveyor; cottonseed is usually tramped to secure greater storage, thereby increasing the horizontal pressure.



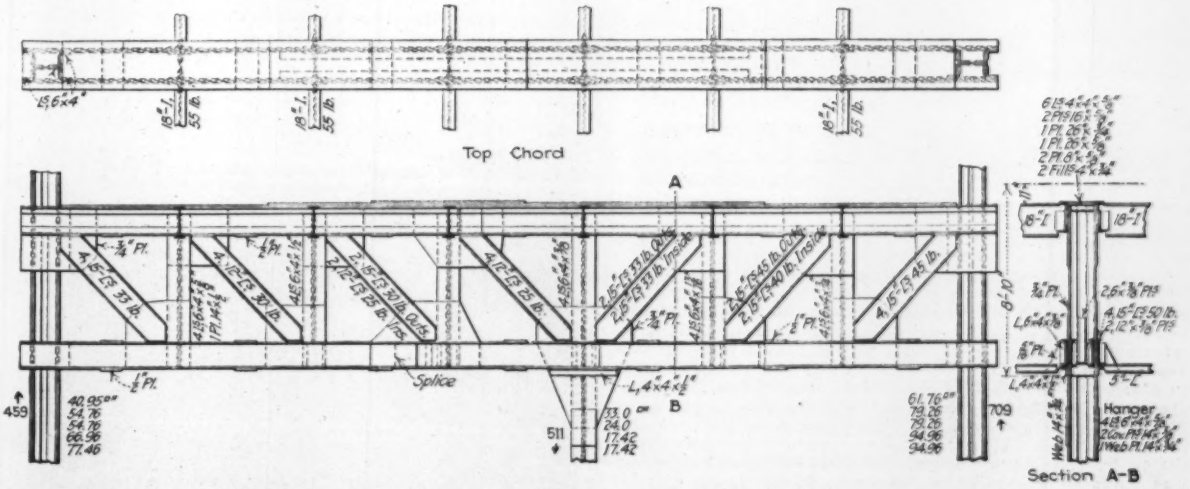

HORIZONTAL PRESSURE OF LOOSE COTTONSEED UNDER INCREASING HEADS

Weight of loose seed = 22.4 lb. per cu.ft.
Weight of packed seed = 33.6 lb. per cu.ft.
Angle of repose of seed = 38° 40'.
Equation of curve,

$$P = \frac{5}{2} H$$

As the available experimental data were limited, the writer undertook to make some tests of the horizontal

*713 North Lancaster Ave., Dallas, Tex.




TRUSS CARRYING FOUR FLOORS ON HANGER BARS, PUBLIC SERVICE RAILWAY TERMINAL, NEWARK, N. J.

pressure as measured in a working cottonseed bin. The side of the rectangular tunnel through the center of the building extended only 1 ft. above the top of the vertical 3x4-ft. pressure door at which the measurements were made, and as the nearest wall was 25 ft. away, the side-wall friction was negligible. The conveyor opening was 35 ft. above the center of the door and 8 ft. to one side. The pressure of the seed was measured just as it fell, without any further packing. The average head on the door was obtained by measuring the vertical distance from the center of the door to the line of the sloping seed.

The pressure was transferred through levers to a platform balance scale. No system of spring scales or pressure diaphragms could be used, as the slightest movement of the door would cause a marked change in the pressure. When the door was removed at the completion of the test, the seed remained nearly vertical, less than a cubic foot falling down.

By referring to the diagram, it will be noticed that a considerable break in the pressure occurs when the filling is delayed, but that this loss is soon fully recovered. Since the whole mass of seed is in a constant state of readjustment while the head is being increased, it is the writer's opinion that as soon as the set acquired during the intermission is broken, the pressure becomes the same as if no delay had occurred. Although the pressure on a wall decreases with time, it would seem that nothing is gained by partly filling a building and allowing the seed to set.

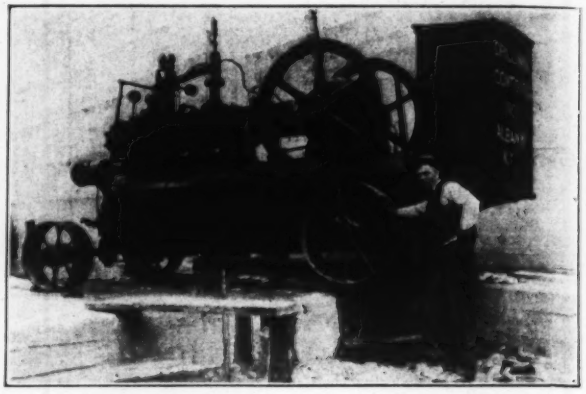
One way of designing a wall to retain cottonseed is to allow for the pressure of the loose seed and the effect of tramping, when such packing is not permitted nearer than 10 or 12 ft., depending on the height of the wall. Another method is to make the wall much stronger so as to resist the pressure when tramping is permitted next to it. The latter is more fool-proof, but the former is probably the better practice, as more seed can be stored in that way for each dollar invested.

This test was made with the coöperation of J. H. Brillhart, Chief Engineer, Mosher Manufacturing Co., Dallas, Tex.

## NOTES

**Good Performance of a Ditching Dredge** was made by a 2-yd. dredge working on Joint Ditch No. 17 in Emmet and Palo Alto Counties, Iowa. This ditch drains the eastern half of Swan Lake and the adjacent lands. The main ditch from the junction of the laterals was 17½ mi. long and 5 to 15 ft. deep. The bottom width was from 18 to 24 ft., with slopes of 1½:1. In places the bottom was very hard. The dredge was operated until Jan. 1, 1915, and then was frozen in until Mar. 1. The frost was 18 in. deep in March and some zero weather was encountered. There was 959,000 cu.yd. to be excavated in the contract, and the work was finished Oct. 15. The dredge was operated double shift, time for repairs being only on Sundays after the boiler work was attended to, and no labor was employed except the regular crews of four men on each shift. In the final month, Sept. 15 to Oct. 15, the dredge cut a ditch 38 ft. wide on top, 24 ft. wide on the bottom and 6 ft. deep, 21,180 ft. long (or 4 mi.) in 26 working days. There were no breakdowns during the month and the dredge quit in good working condition. Considering that the work was in the country and that all repair work was handled by the operating crews, it is natural that the steady work with double shift would cause wear and tear that would bring delays at the close of the work.—H. B. Whitney, Contractor, Emmetsburg, Iowa.

**The Importance of Portable Equipment** for contractors is emphasized by a report of the Drilling Contracting Co., 3 State St., Albany, N. Y., on a portable air-compressor outfit used by the concern on its New York State Barge Canal work. The machine has been put on cars only four times, yet it has been set up on all of the eight locks below Fort Edward on the Champlain Canal, on all the 22 locks of the Erie Canal between Waterford and Oneida Lake, and on the

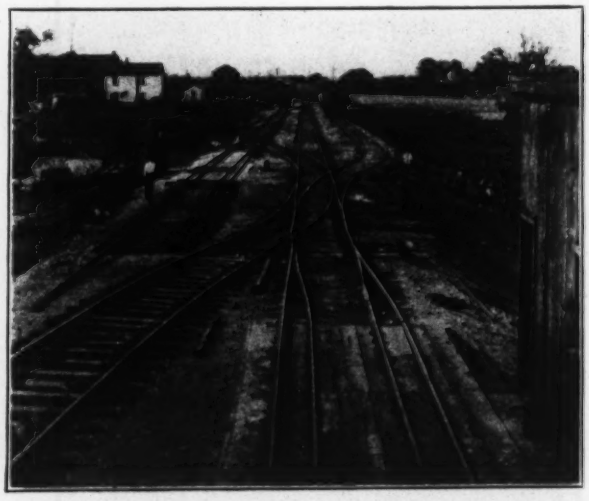


PORTABLE COMPRESSOR OF DRILLING CONTRACTING CO. OF ALBANY

locks at Fulton, Minnetto and Oswego of the Oswego Canal. It is at present working on the four locks of the Cayuga and Seneca Canal. The company reports that it has become so much a matter of routine to sling the portable outfit around by cranes that it requires only about 15 min. to get drills running after placing the compressor on a new site. The photograph shows this compressor going into position at Lock 3 on the Cayuga and Seneca Canal. The unit is run at times 24 hr. a day, with only a 10-min. stop for examination of journals and wristpin connections. The machine was furnished by the Chicago Pneumatic Drill Co.

**A Turnout Within a Turnout**—An unusual piece of temporary trackwork is shown by the view. In order to make extensive repairs to a set of "light" railroad track scales it was necessary to remove the dead and running rails, but at the same time maintain the empty-car traffic normally passing over these scales and without tying up the loaded-car traffic passing over the "heavy" scales.

The desired result was obtained by cutting the "light" track at one point and connecting by turnout to the "heavy"



A COMPLICATED TEMPORARY TURNOUT ARRANGEMENT

track. Empty cars were weighed on the "heavy" scales and by a back-up movement were passed over the temporary connection and to the storage yard beyond. For this information I am indebted to H. C. Finch, general manager of the Genesee & Wyoming R.R., Retsof, N. Y.—J. R. Taft, New York.

# Editorials

## Maladministration Responsible for Late Factory Fires

The fire question has come very much to the fore in the last week. The destruction of the Bethlehem and the Roebling shops may be passed over here. The real matter of concern is the series of terribly fatal fires in city factories, of which Pittsburgh furnished one three weeks ago and New York another ten days later. The two dozen victims of these fires were a needless sacrifice. There is no instruction in the details of the disasters, nothing to be learned from them that will help in saving other lives in the future. In both cases the victims were penned up in firetraps—a commonplace word in our modern language, but how appropriate to the working-places and the buildings which were burned!

Let it be emphasized that the art of fire-protection—and this is an engineering study—long ago reached the point of recognizing clearly the inevitableness of such fires as those in Pittsburgh and New York. Combustible buildings, conditions that encourage rather than prevent the start and spread of fire, lack of means of exit, absence of fire warnings and fire-fighting means, and all the other elements that mean death soon after the first chance flame springs up, have time and again been observed in their disastrous action and marked down as things that must be eliminated if even reasonable safety is to be attained. But between this knowledge and its full utilization there stands, in some states and cities, a wall of administrative incompetence and neglect that is horrifying.

No more grotesque characterization of this administrative failure has ever been given than was supplied by the state inspecting board of New York in the inquest on the fire of Nov. 6. The board's inspectors testified that they inspect factories of six stories and more and factories of four stories and less, but no *five-story factories*. The board never made regulations for five-story factories! For months it has gravely discussed, in a dozen different board meetings, says the chairman, the question of making such regulations. And once, when they had a public hearing on this weighty question, representatives of manufacturers' interests came to protest, saying that it would be a crime and a useless expense to extend the fire rules to five-story factories! And even today the board has no rules for this class.

But the cause of this particular fire lies farther back even than the wonderful board. It goes back to the Triangle shirtwaist fire of evil memory. Tremendous excitement among the public and the authorities of city and state was aroused by that fire; yet when, long afterward, Harris and Blanck, the operators of the factory, came into court under indictment for keeping their employees locked in, they were acquitted. The encouraging lesson—that the most necessary laws may be violated with impunity—was not lost on their successors.

Another interesting example illustrates a different phase of the subject. Some years ago a great new department store was to be built. Department-store crowds and the large open floor areas—which it has never been possible to restrict by legal limitation—need ample stairway provision for quick escape in case of fire. The stairway requirements of the law are none too ample. But in this particular case the owner did not want to provide as many stairways as the law requires. All the technical officials who had to pass on the case insisted on the full legal provision of stairs. But there were some high officials—nontechnical men; in short, politicians—who were also interviewed. The final result, no matter how it was brought about, was that fewer stairs were put in than the plain reading of the law requires.

A department store of the present-day type constitutes a large fire danger. Good luck has kept fire away, and for fifteen years there has been no department-store conflagration. When it comes, it may, by chance, seize on the store with inadequate stairs.

Inadequacy of laws or their absence and maladministration make illusory, in a large measure, the public's protection from fire danger. Engineers are concerned with this situation to the extent that they can influence current thought toward reform.

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## Two Tunnels to Make One

One way of doing a thing well is to do it twice. Ordinarily this is an uneconomical procedure, but the builders of the Rogers Pass tunnel claim that it is economical in their case. They had a long tunnel to dig, and so they started by excavating a second tunnel, a useless tunnel, first, and from it they proceeded to attack the main tunnel itself.

To describe the striking, iconoclastic method of the "pioneer heading" in the above terms is likely to seem belittling and unfair. The work was carried on in highly successful and expeditious style. Record-breaking rates of advance were made, greater at least than any prior performance on the western continent. No untoward incidents interfered with smooth progress. So the work merits congratulations and praise. That fact however does not bar the question whether the second-tunnel scheme was an essential factor, or whether the same or even better results would have been attained without it.

Comparison with the Simplon tunnel is invited, because there the parallel-heading method was also used—in fact it was originated by the Simplon engineers. Two reasons in coöperation made a sound basis for the method there: First, the prospects were that great heat and large water-flows would be encountered, which would call for drainage and ventilation capacity almost impossible to secure in a single heading; and second, if for purposes of ventilation and drainage a second heading were driven along with the main heading, it could be used later for the second tunnel which would shortly be needed to provide double track, and so the parallel heading would involve hardly any dead expense.

There has been much difference of opinion in Switzerland among tunneling experts as to whether the Simplon experience justifies the existence of the parallel-tunnel method of construction. In the later Loetschberg tunnel, which is shorter than the Simplon but still much longer than the Rogers Pass, the method was not used; and although this is a double-track tunnel there is no ground for assuming that the greater width had anything to do with the selection of the driving method. The conclusion is probably conservative that for the Simplon itself the parallel-tunnel method was a vitally important device, making possible the successful handling of great springs of water, oppressive heat, and swelling rock; but that it established no valid precedent for other tunneling operations.

It is pertinent to remark that none of the critical conditions of the Simplon were present in the Rogers Pass problem—neither much water and heat, or unsound rock. Moreover, the builders of the latter say directly that, despite the outward similarity, their method has no relation to the Simplon method. They were aiming at speed of advance.

This reduces the case to a simple question, which, it may be hoped, the Rogers Pass engineers will answer in due time: Wherein does the supposed gain of speed or convenience by the parallel-heading method lie? It cannot lie in the heading advance itself, since the main heading should get along just as fast as a parallel heading, in respect to work at the face, and since no difficulty has been found elsewhere in passing the heading muck through the break-up and enlargement work in the rear. To cite only one case of proof: the Loetschberg headings, while break-up work was proceeding very actively at numerous points back of the face, were uninterruptedly driven forward at a very much faster rate than Rogers Pass has been able to report, so that the Loetschberg or standard method cannot be materially inferior to the Rogers Pass method in regard to muck disposal.

Drainage was not a factor at Rogers Pass, it appears, for if it were the pioneer headings would have been driven on an up-slope, to drain. Ventilation, however, may have had important bearing, and a clear statement of how much account was taken of ventilation in adopting the tunneling method will be a most desirable thing.

## Another World Record Broken

*Engineering News* owes a mild apology. Success always overcomes carping criticism, and the Philadelphia Engineers' Club has recorded a sweeping success. The club's campaigners did not go after a million members, as a jealous Pittsburgh newspaper said—see *Engineering News* of last week—but only after a modest thousand. "Modest" is true only in contrast, however, as there is nothing small about the project of gathering in 1,000 new ones in four days. It means, says the local mathematician, 250 per day, or in the 14-hr. working day 18 members per hour. Every 3 min. 20 sec. a new candidate was to be signed, sealed and delivered. That is real ambition.

But what did they do? They not only made good but they had 67% to spare! No less than 1,776 persons not previously members of the Philadelphia Engineers' Club were convinced by the earnest arguments of the membership solicitors.

To convert this phenomenal achievement into a permanent triumph will call for further work, harder than the efforts of the whirlwind campaign. The club must now "deliver the goods," to speak in worldly phrase. Recent Philadelphia history teaches us how hard it is, after the newly awakened sleeper has "hit the sawdust trail," to keep him awake. Let the club put forth its efforts to this end. Let it show that members can be not only secured but also retained.

## Low-Cost Reinforced-Concrete Water-Works Conduit

Engineers may well be set to thinking by the low unit cost of the 27 mi. of 42-in. reinforced-concrete pipe for the new water-supply of Victoria, B. C., described elsewhere in this issue. The cost was not much over the bid for wood-stave pipe and only a little more than half the bid for riveted-steel pipe. It should be noted, however, that the pipe was laid on the hydraulic grade line, in a rough and heavily timbered country, with local cement and with sand and gravel readily available. It may be mentioned that the carrying capacity of the pipe exceeds the estimated capacity by a considerable percentage. What the life of the conduit will be as compared with wood and how water-tight it will prove after the test of service are interesting subjects for speculation. Instead of evil, *Engineering News* prefers to prophesy a long life, and a useful one, for this concrete conduit—which, by the way, has below it 11 mi. of 36-in. riveted-steel pipe under pressure, conveying the same water, and thus affording some chance for comparing the two materials.

## Sidelights on the Philadelphia Valuation Conference

The recent three days' discussion at Philadelphia of appraisals, values and depreciation of public-utility properties (noted elsewhere in this issue) was of peculiar interest as disclosing the tendencies of responsible men connected with the public side of utility regulation the country over. There were represented, of course, all shades of opinion. The utilities themselves were not unrepresented, even though the conference was held under the auspices of the Utilities Bureau, which aims to be the organization of the public side nearest approaching the various well-known associations of utility companies and men. The utilities might have been more largely represented had they not, as there is reason to believe, been afraid of giving the impression of trying to strangle coöperation among public bodies and public men. It was evident throughout all the discussions (and it likewise has been evident in recent meetings of utility-corporation men) that equity to both public and corporation was the goal. Of course there were inevitable differences as to just what constituted real equity and how it was to be approached—differences arising from somewhat antagonistic viewpoints. But the spirit of equity seemed generally to dominate. A few years ago this was not wholly true on either side of the case, and its development is an encouraging evidence of the benefits of state regulation.

One idea accepted by the gathering was that the introduction of the term "value" had been unfortunate.

All parties, except possibly one prominent railroad attorney, who stood firmly on the bedrock of Supreme Court decisions as fixing the law of the land, were seeking to find as a rate basis not the economist's market value of plant and business (which depends on rates) but an equitable worth on which the utilities should turn—as one speaker put it, "a basis of compensation for the sacrifice of the investor." Reproduction cost of property and business under present conditions was assailed as the basis of rates; but as single elements tending to show the earning worth which a commission might equitably establish, reproduction under present and under historical conditions was finally accepted. Thus it may be seen how advantageous it is to clear away some mutual misconceptions of terms which in the past have caused needless controversies.

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A heart throb of approval and sigh of regret will be evoked from every engineer in the public service who reads the following words from a recent report by M. L. Cooke, Director of Public Works of Philadelphia: "With the exception of a very few positions, the men in this bureau are not well enough paid. The whole salary schedule should be revised, and upward." Some might say that the best and only way to remedy this deplorable state of underpay is well-conceived publicity work. That the author of the report believes in publicity no one who knows him and his work can doubt. But he urges other means just here—means, too, quite within the reach of every engineer, but too commonly overlooked and neglected. To quote again: "It has always been a personal theory of mine that the way to get one's salary increased is to study to do better work and to have the salary increase come as a byproduct." Not only better work, but also more of it, might well be the study of many engineers in both public and private service who are more inclined to form a new mutual-admiration and raise-our-pay society than to strive every day to do their best, be their salary high or low. When maximum output and perfect quality have been secured it will be found that many barriers to effective and desirable publicity have been broken down—and the way paved to higher salaries.

# Letters to the Editor

## Sand-Cement and Mortar Beds for Paving--A Difference

Sir—The relative merits of sand and mortar beds under brick and block pavement continue to be a matter of active discussion. I notice that writers on the subject in referring to mortar beds seem to have in mind two quite different kinds of material. The one is a so-called mortar made of sand and cement mixed with only sufficient water to dampen it, resulting in a pulverulent mass that can be handled and gaged like damp sand; the other is a true and quite soft mortar.

The former has been more or less used as a substitute for sand alone for a long time; the latter is a comparatively new substitute for the common sand cushion. The writer has always meant this latter in speaking of mortar beds. The difference between the two is not alone in the quantity of water used in making it up. The merely dampened mixture of sand and cement is inferior to the real mortar. It does not set up into a mass of anything like the same hardness and strength as the true mortar. This was proved by the writer in experiments made over twenty years ago. The results of the tests have been mislaid and I cannot give the exact figures.

The experiments may easily be repeated and the statement verified by making up cubes of the two mixtures, using the same ratio of sand and cement and crushing them after the usual period of setting; or the striking difference in hardness between this so-called mortar and the concrete in the foundation may usually be observed in cutting through a pavement several years old.

It will sometimes be difficult to tell in places whether the cushion was so-called "mortar" or ordinary sand. This is partly because block pavements with close joints, even where the joints are not filled with impervious material, may not permit sufficient water to reach the cushion to complete the setting process for a long time, and the jar of travel over the pavement may break up the incipient setting, leaving, in places at least, only the equivalent of a sand cushion. Furthermore, tests will show that the dampened sand and cement, so frequently called mortar, if first compacted into a mold and then kept saturated with water will never attain the hardness and strength of the same composition well mixed with sufficient water to make a true mortar.

In order that results and experience may be properly compared, it should always be noted in reports of mortar beds whether real mortar or a moistened mixture of sand and cement (which might be designated as semi-mortar) is used; also, whether the mortar bed is applied before or after the foundation concrete has set. Unless the former method is followed, the effect of monolithic construction may not be fully attained.

New York City, Nov. 11, 1915. S. Whinery.

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## Colleges and the Development of National Resources

Sir—The German Government testing stations in technical colleges have contributed greatly to German industrial efficiency. Why cannot the United States Government so utilize the brains and equipment of the Land Grant Colleges? To this end your readers' coöperation is solicited in connection with a proposed bill for "mechanic-arts experimentation."

By the terms of the proposed bill there will be established under the direction of the land-grant college in each state a department to be known as a "mechanic-arts experiment station" for the purpose of conducting original researches, verifying experiments and compiling data in the mechanic arts and in their application to the

improvement of conditions of the rural and industrial classes of the United States; also for conducting researches, investigations and experiments in connection with the production, transportation, extraction and manufacture of substances utilized in the application of mechanic arts to industrial pursuits, and such other researches or experiments bearing directly on the various industries of the United States as may in each case be deemed advisable, having due regard for the varying conditions and needs of the respective states.

For the purpose of carrying out the requirements of the proposed bill the Federal Government will be asked to appropriate a sum of $15,000 per annum to each state. In order to secure uniformity of methods and results, some department of the United States Government will be designated as coördinator, to act in the same relation to the proposed mechanic-arts experiment stations as that now existing between the Department of Agriculture and the agricultural experiment stations.

In several states, including Illinois and Iowa, appropriations by state legislatures for research in mechanic arts have been occasioned by the demand from the industrial interests of the states for scientific experimentation relating to mechanic arts. That these appropriations were well utilized is evidenced by the fact that about 150 bulletins were published by these two stations within the past 10 yr., the largest portion of which is among the most authoritative literature on the subjects treated.

The land-grant colleges of about 15 other states maintain definite organizations for carrying on research in mechanic arts, but have no support from their states or from other sources for such investigations.

Experiment stations in the mechanic arts will also cooperate with the agricultural experiment stations in solving engineering problems which are intimately related to the industry of agriculture. Such problems include flood protection, drainage and irrigation, water-supply, sewage disposal and farm sanitation, rural architecture and road building. The proposed Federal aid for systematic experimentation in mechanic arts is analogous to the aid provided in the Hatch Act of 1887 and is for the purpose of paralleling the excellent work which has been carried on by agricultural experiment stations.

The Hatch Act and the proposed bill are alike supplementary to and in full accord with the Morrill Acts of 1862 and 1890.

A. A. Potter, Secretary,
Land Grant College Engineering Association.
Manhattan, Kan., Oct. 26, 1915.

## NOTES AND QUERIES

**Queens Boulevard Concrete Elevated Structure**—By accidental omission the article published Nov. 11 on the concrete arch elevated structure on Queens Boulevard, New York City, failed to state that Noble & Woodard, consulting engineers to the Public Service Commission, were consulted in reference to the design.

**Smooth Railway Crossings**—A correspondent in South Carolina asks to be informed about the financial benefit to a railroad or street-railway of "automatically operated, perfectly smooth crossings." The only such crossings that the editors have been informed of are used by the Pacific Electric Co., in Los Angeles, and are made by the Cobb Shockless Crossing Co. (described in "Engineering News" of June 10, 1915, p. 1151). Where two tracks cross, the rails not in use are depressed so as to have a continuous rail surface for the approaching car or train. The financial benefits have not yet been disclosed.

## Sooke Lake Water-Supply for Victoria, B. C.*

By C. H. Rust†

A new $2,500,000 gravity water-supply for Victoria, B. C., has recently been provided, consisting of the raising of Sooke Lake 12 ft., the building of a 38-in. conduit and a storage reservoir of 136,000,000-gal. (Imp.) capacity. The upper 27.3 mi. of the supply conduit is of reinforced-concrete lock-joint pipe and the lower 10.75 mi., below the storage reservoir, is of riveted steel pipe. The original contract, which provided for 40-in. instead of 42-in. concrete pipe, was abandoned. Under the new contract 42-in. pipe was used, for reasons stated farther on.

Victoria has a population of about 50,000. The daily consumption of water in the summer is 80 Imp. gal. per capita; in winter, 50. All services are metered.

From 1873 to 1913 the city procured its water-supply from Elk Lake, about 5 mi. northeast of the city. The capacity of Elk Lake being only about 2,500,000 Imp. gal. a day, the city was compelled to procure a more ample supply. It was decided to bring water from Sooke Lake, which drains an uninhabited forest area of 31½ sq.mi. The lake is about 4 mi. in length, and its maximum area at 555 ft. above sea level is 978 acres. It was decided to construct a dam at the foot of the lake and raise the level 12 ft., increasing the area to 1,180 acres.

It is proposed ultimately to utilize the Leach River watershed, with an area of about 31 sq.mi. the water from which can be turned into Sooke Lake by constructing a 5-mi. conduit. If it should be necessary, the dam at Sooke Lake can be raised to a height of 45 ft., giving a reservoir storage of 17,358,000,000 Imp. gal. The scheme which has now been completed gives a reservoir capacity of 5,555,000,000 Imp. gal.

The contract for the new supply called for the clearing of the land around Sooke Lake 15 ft. above low water and the construction of a dam, with screen house, intakes, etc., at the foot of the lake; 27 mi. of 40-in. concrete pipe and 27 mi. of 2-ft. gage railway track; a telephone line; the clearing of a reservoir site at Humpback, 12 mi. from the city, and the erection there of a dam, screen house, valve chamber, venturi meters, etc., and the building of 11 mi. of 36-in. steel pipe leading to the city reservoir. The contract for all this work was awarded to the Westholme Lumber Co., of Victoria. The following were some of the figures: Earth excavation, from 60c. to $1.50; rock excavation, from $1.75 to $7.50, the former being the price on the concrete pipe line. The prices for clearing land around the lake ranged from $150 to $250 per acre.

For the pipe line from Sooke Lake to Humpback Reservoir bids were received on three classes of pipe. The bids of the successful contractor for pipe laid and installed were: Wood-stave pipe, $2.47 per foot; riveted-steel pipe, $5.50 per foot; reinforced-concrete pipe, $2.53 per foot. It was finally decided to use the concrete pipe.

On the pressure line from Humpback Reservoir to the city, tenders were invited for three kinds of steel pipe.

*Slightly condensed and rearranged from a paper read before the American Society of Municipal Improvements, Dayton, Ohio, October, 1915.

†City Engineer, Victoria, B. C.

The prices bid by the contractors were: Lap-welded, $7 per foot, laid and connected; riveted-steel plate, $\frac{5}{16}$ in. thick, $5.25; $\frac{3}{8}$ in. thick, $6.25; lock-bar pipe, $6.80. It was decided to use riveted-steel pipe.

The contractors commenced work early in 1912, but the progress made was not at all satisfactory, and in April, 1913, they abandoned their contract. The writer, as Water Commissioner, recommended to the Council that the work be proceeded with by day labor. This was approved and the city immediately put on a large force of men at various camps. The laborers were paid $2.75 per day for 8 hr., $1 a day being deducted for their maintenance. Free medical attendance was supplied by the City Medical Health Officer.

The city completed the clearing of the land at Sooke Lake, carried out the construction of the dam, headworks, etc., at the foot of the lake and built the dam at Humpback.

It was considered advisable to call for tenders for the conduit. The contract for the construction of the concrete pipe was awarded to the Pacific Lock-Joint Co., and in place of 40-in. pipe, the contractor, having the necessary forms on hand, agreed to construct 42-in. pipe for the same price, its tender being $2.29 per foot, including laying and installation, but not transportation.

The concrete pipe had a shell 3 in. thick and was made in 4-ft. lengths, except the pipe used for siphons, which was more heavily reinforced and had a 4-in. shell.

The city awarded the contract for the fabrication and laying of the riveted-steel pipe to the Burrard Engineering Co., of Vancouver, at the following prices: $\frac{5}{16}$ in., $5.50 per foot; $\frac{3}{8}$ in., $6.25 per foot; but the city carried out by day labor the necessary excavating and backfilling. This line is 56,677 ft. long and was built and laid in six months.

For the construction of the concrete-pipe line a right-of-way 100 ft. wide was secured. All trees on this strip were cut down and any tall trees outside this area, which might in falling damage the pipe, were removed. The concrete pipe is not covered except immediately in the vicinity of the Humpback Reservoir, where it was thought slides might occur. Open standpipes are located 2,000 ft. apart on the conduit line, and each of the six inverted siphons has a waste outlet at the bottom controlled by a 6-in. gate valve. The deepest siphon is 600 ft. in length and has a maximum head of 90 ft. The whole of the concrete pipe line, which is 144,040 ft. long, was constructed on a grade of 1 ft. in 1,000 ft. The first pipe was made Apr. 20, 1914, and the pipe line was finished May 20, 1915.

The Humpback storage reservoir, about 11 mi. from the city, was formed by building a 60-ft. concrete dam across the valley of a small stream. It has a storage capacity of 136,000,000 Imp. gal. and floods an area of 33½ acres, originally covered with a very thick forest. A portion of the reservoir site had black soil of peaty nature. It was decided to cover this with a 6-in. layer of clean gravel.

The water flows into this reservoir from the concrete pipe line over a series of steps. There is also a 24-in. bypass to the pressure line. During the summer of 1915, owing to algæ in the reservoir, the water was sent to the city through this bypass.

Because of the great pressure, it was decided instead of delivering the water direct to the city to permit it to overflow into Smith's Hill Reservoir, situated within the city and having a capacity of about 15,000,000 Imp. gal., which acts as a pressure regulator.

To protect the watershed of Sooke Lake from any possible danger of pollution, the city purchased the whole area of about 15,000 acres for $12 per acre. It expects ultimately, if it so desires, to more than compensate itself for this outlay by disposing of the very large amount of valuable timber which is on the watershed.

The abandonment of the work by the contractor, the Westholme Lumber Co., led to a protracted litigation. The company entered suit against the city, claiming $500,000 damages. The suit was heard in Victoria last winter, and the judge hearing the case was assisted by two assessors, who were civil engineers. The case lasted six weeks and a verdict was given for the city, but the company has appealed and no doubt the case will be prolonged for some time before final decision.

The system was completed and put into use on June 2, 1915. No fatal accidents occurred during construction.

The original contract called for the delivery of 16,000,000 Imp. gal. per 24 hr. through a 40-in. pipe. The maximum flow through the 42-in. pipe actually built, as determined by test, was 22,400,000 Imp. gal. in 24 hr.

One accident has occurred to the concrete pipe line. During a forest fire a tree came down the side of the mountain and broke one pipe and cracked six more. Repairs to the two breaks, however, were quickly made.

The contractors for the concrete pipe line agreed to maintain the pipe for a period of one year. At present there is a leakage in the 27 mi. of about 500,000 Imp. gal. per 24 hr. It is expected that these leaks will be entirely eliminated when the necessary repairs are made.

The following is the actual cost of work by the city:

Sooke Lake Dam

| | Per Cu.Yd. |
|---|---|
| Earth excavation | $1.42 |
| Rock excavation | 4.24 |
| Concrete in foundation of dam | 15.68 |

All the cement had to be shipped by rail and hauled by teams about 10 mi. over very rough roads. The gravel and cement were procured from the upper end of the lake and had to be towed to the foot of the lake. This involved the placing of a tug in the lake, which had to be transported from Victoria over the mountain, and the construction of scows.

Concrete Pipe Line

| | Per Lin.Ft. |
|---|---|
| Pipe | $2.32 |
| Concrete trestles for pipe line | .18 |
| Railroad | .53 |
| Transportation | .33 |
| Total | $3.36 |

Telephone Line

| | |
|---|---|
| Per mile | $426 |

Steel Pipe Line

| | |
|---|---|
| Contract price for $\frac{1}{4}$-in. pipe, per lin.ft. | $5.50 |
| Contract price for $\frac{5}{16}$-in. pipe, per lin.ft. | 6.25 |
| Earth excavation, day's work, per cu.yd. | 1.32 |
| Backfilling, day's work, per cu.yd. | .55 |

Humpback Reservoir

| | |
|---|---|
| Earth excavation, per cu.yd. | $2.09 |
| Rock excavation, per cu.yd. | 12.78 |
| Clearing, per acre | 605.00 |
| Placing gravel in bottom, per cu.yd. | 2.48 |
| Concrete foundations for dam, per cu.yd. | 9.00 |
| Concrete in dam, per cu.yd. | 10.05 |

These prices include plant, tools, equipment, supplies, bookkeeping, etc.

Wynn Meredith, of the firm of Sanderson & Porter, New York, was engineer for the work. He was represented on the ground during the progress of the work by Boyd Ehle.

The entire cost of construction, including engineering, etc., was $2,037,176, and the cost of land, including right-of-way for pipe lines, site for Humpback reservoir, land adjoining Sooke Lake and the Sooke Lake drainage area, in all amounted to approximately $540,000.

# Making a Road Up the Palisades

*SYNOPSIS—Building a road to carry heavy traffic on an easy grade up the steep slopes of the Palisades at New York City. The road is brick-paved, and is guarded by a heavy parapet wall with novel coping.*

On the west bank of the Hudson River, opposite New York City, rises the long range of trap-rock precipices known as the Palisades. Their summits are 400 to 500 ft. above the river, and the cliffs themselves have a height of 50 to 100 ft. From their foot, a steep rock-strewn slope well forested extends to the river. These cliffs and the slope below them to the river were made a public park by joint action of the New York and New Jersey legislatures fifteen years ago, and were placed under jurisdiction of an interstate commission, a body that is unique in being, so far as is known, the only example of an organization empowered to carry out a public work by the joint authority of two states.

From the first it has been planned to build a driveway through the park along the west shore of the river, and this projected road was long ago christened the Henry Hudson Drive. It is planned to have this driveway eventually extend and complete a through highway along the west bank of the Hudson from New York to Albany.

The first section of this drive, known as the "Englewood Approach," was completed and opened in June, 1915. It consists of a roadway starting from the top of the cliffs at Englewood and pursuing a zigzag course down a steep slope to the river, where a ferry to Dyckman St., New York City, has been established. The new road becomes the best avenue for through automobile travel to New England, where it is desired to avoid the crowded streets of downtown New York. The easy grades of the new highway tend to make it the favorite route for most of the pleasure travel between New York City and New Jersey.

The new roadway across the Palisades Park follows the general route of an old road built seventy-five years or more ago, which took advantage of a natural break in the cliffs. The old road was a very narrow sidehill cutting, supported on the lower side by rough stone walls which, while they had only a shallow footing and were only one course thick—a mere veneer for the earth backing, in fact—had stood up surprisingly well.

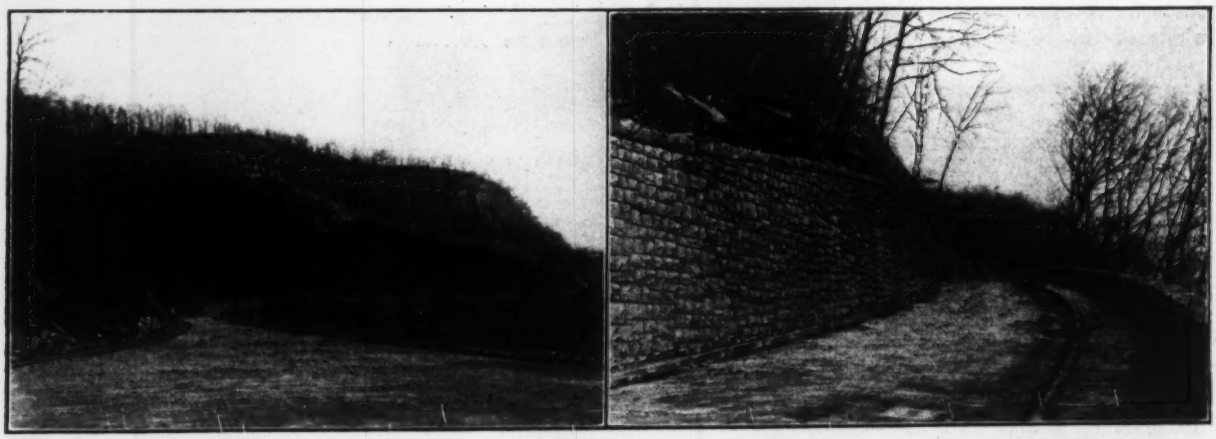
In order to make a roadway wide enough to carry the expected traffic, it was necessary to cut much farther into the steep slope, and support the fill on the lower side by a high and substantial retaining wall. On the upper side also, along the lower section of the road, it was eventually found necessary to hold the caving earth and disintegrating shale of the bank by a substantial wall. The lower wall was built of dry rubble; the upper one of dressed stone laid in cement. All these walls were built of the trap rock obtained in excavating the cliffs above.

## A Road Down a Cliff

On the middle section of the roadway the old road passed along a narrow ledge half way down the face of the vertical cliff, nearly a hundred feet in height. The necessary widening of the roadway, therefore, meant either very high wall work to support the lower side or the excavation of a great amount of rock from the high cliff. The former plan was followed on the lower section, and as the road ascended and the height of the cliff above it became lower, the width was gained wholly by excavation.

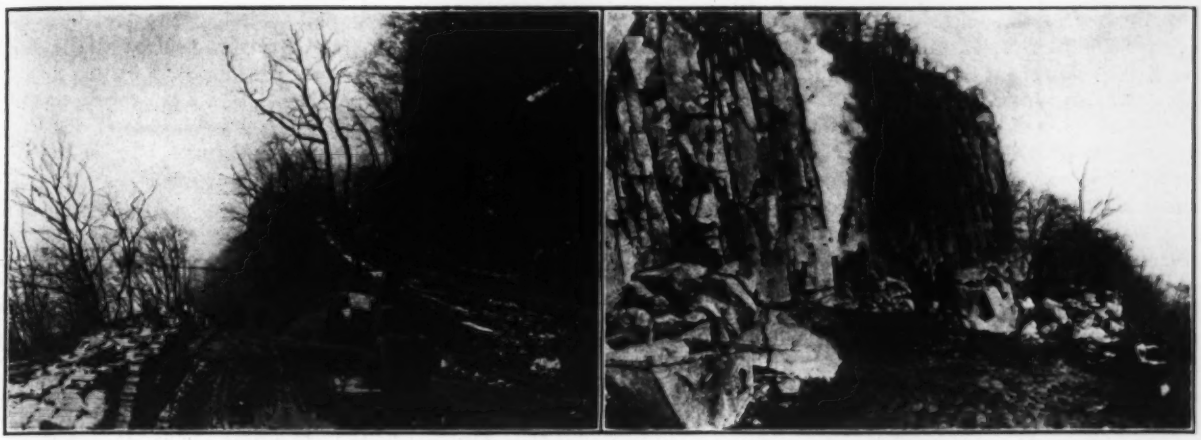
The accompanying topographical map with the general view gives a good idea of the route followed by the new roadway. It may be noted that very heavy excavation was required at the two "loops," or hairpin turns, to obtain sufficient width to enable vehicles to turn safely without interference between the ascending and descending streams of traffic. The grade of the roadway is about 8%. This has proved very satisfactory for automobiles.

The lower side of the roadway is protected for the whole distance by a very heavy parapet of trap-rock masonry. The coping for this parapet is of massive blocks roughly dressed and rounded, and harmonizing with the general rough and wild character of the landscape. The blocks are so heavy and substantial that they are not likely to be lifted off and cast down the slope by mischief makers, and they form a surface too rough to permit anyone to walk along their tops.



FIGS. 1 AND 2. TWO VIEWS OF THE ENGLEWOOD APPROACH; HENRY HUDSON DRIVE, PALISADES PARK

Fig. 1—Looking up the Englewood Approach from the lower end. Taken in the winter of 1914 when the leaves were off; in summer the roadway is nearly hidden. Fig. 2—On the lower section looking toward the first loop. The retaining wall on the upper side of the roadway meets and unites with the wall on the lower side of the upper roadway



FIGS. 3 AND 4. CONSTRUCTION VIEWS ON THE ENGLEWOOD APPROACH OF THE HENRY HUDSON DRIVE

Fig. 3—Winter view during construction; from lower loop looking down lower roadway and up the upper roadway.
Fig. 4—Heavy rock excavation to increase width of road

Much study was given to the selection of the paving for the roadway. It was appreciated that a very heavy traffic was to be expected, for the road will soon become the chief avenue between New York City and a large section of the suburbs in northern New Jersey. Granite and scoriæ blocks were considered, but it was realized that a very large proportion of the traffic would be motor-driven, and it was desired to secure as smooth a pavement as possible. The final decision of the commission, therefore, was to use paving brick of the "hillside" pattern, having a bevel on one side to afford a toe hold to horses. The brick were furnished by the Mack Co., and were inspected at the kiln by the Pittsburgh Testing Laboratory. They are laid on a 5-in. concrete foundation with a 1½-in. sand cushion, the joints being grouted. At the numerous curves "dutchmen," or V-shaped sections, were laid at intervals to keep the courses square with the axis of the road.

### Lighting and Draining Englewood Approach

The roadway is lighted by tungsten series incandescent lamps, placed in porcelain globes carried on low standards set on the parapet wall. The current for the lamps is carried in underground cables, laid in ducts beneath the paving. The roadway drainage is also carried in a pipe sewer beneath the paving, with catch basins at intervals.

A difficult problem was presented by a 6-in. cast-iron sewer pipe which carried the sewage from a few houses on the plateau at the top of the cliffs. This pipe extended down the face of the precipice some 40 ft. in height beside the roadway and was an eyesore that it was desired to remove. Various plans were canvassed for diverting the pipe to other locations, but all were found very expensive. It was then proposed to bore a well in the cliff back of the face, drift in at the foot and drop a pipe with screwed joints down the well to connect with the pipe crossing then built underneath the roadway. Various kinds of well-drilling outfits were investigated, and it was concluded that the ordinary artesian-well sinking outfit would be the most economical. The contract to sink the well was let for a lump sum of $1,000, and the contractor decided to use the chilled-shot method of boring. He made good progress in the solid rock, but the trap of the Palisades is full of fissures and seams, and when these were encountered the shot were lost and boring was suspended. The boring was finally completed, but with greater outlay in time and money than had been anticipated.

### Conduct of the Construction Work

While the Palisades Interstate Park Commission now has its own offices and engineering staff, at the time the road described was undertaken, Watson G. Clark, of Tenafly, N. J., was placed in charge of the work as chief engineer. Surveys, plans and specifications were prepared by Mr. Clark, bids were advertised for, and the contract was let to the lowest bidder, the Miles-Tighe Contracting Co., on a unit-price basis.

The largest item of cost in the work is the excavation, for which the contract price was $1.65 per cu.yd. for rock,

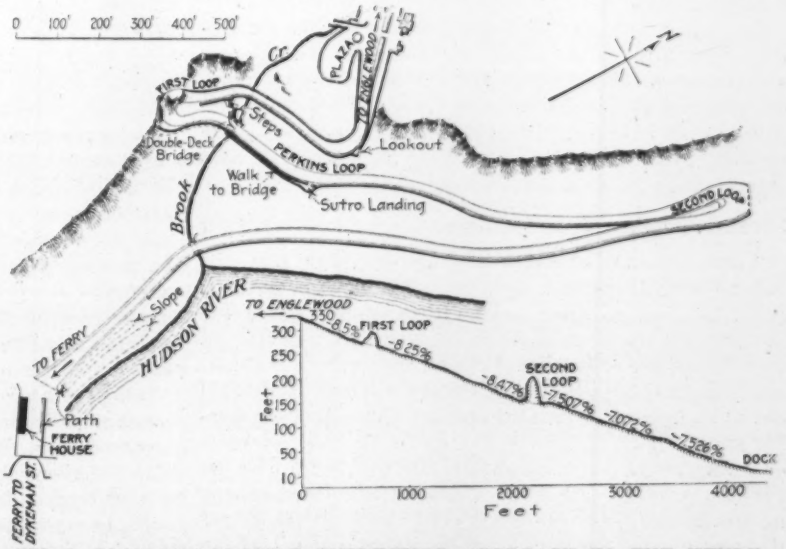



FIG. 5. PLAN AND PROFILE, ENGLEWOOD APPROACH TO THE HENRY HUDSON DRIVE; PALISADES INTERSTATE PARK

and 68c. for earth. Nearly 39,000 cu.yd. of rock and nearly 26,000 cu.yd. of earth were removed. The masonry walls cost about $57,000, in which the largest items were 7,900 cu.yd. of dry rubble at $2 per cu.yd., 80,000 cu.ft. of parapet wall at 40c. per cu.ft. for two-faced wall and 30c. per cu.ft. for one-faced.

Structural concrete at $12 per cu.yd. accounted for nearly $50,000 of the cost. It proved necessary to use a great deal of concrete in leveling up the footings for the retaining wall and filling openings in the high cliffs to support the roadway on the lower side. The brick paving cost about $41,000, there being over 12,000 sq.yd.

The total cost of the roadway, about 4,000 ft. in length, including engineering and inspection, will be over $300,000. This includes the electric-lighting equipment already referred to and also the construction of a large paved plaza at the summit, where those who come there to see the view may park automobiles.

The work of construction has been supervised by a committee of the commission, of which Abram De Ronde was the first chairman. Upon his retirement from the commission, he was succeeded by Col. E. A. Stevens, and he in turn by Charles Whiting Baker.

## Use of Water in the Modesto Irrigation District

By Kenneth A. Heron*

During the season of 1914 the writer conducted a series of irrigation investigations in the Modesto Irrigation District. Records of canal flow and irrigation methods were kept in such detail that it is believed they may be of value as illustrating irrigation practice in central California.

To record the canal flow during the season, gaging stations were established on all the principal canals and laterals and readings made daily and twice a day by the ditch tenders and water distributors. For the purpose of observing irrigation methods 15 representative tracts, ranging from 20 to 80 acres in size, were selected and complete records of the manner of using water and of the crop obtained were kept.

As 86% of the 46,000 acres in cultivation in the district is in alfalfa, the tracts selected were in this crop, and records on these fields consisted of soil report, depth of ground-water measurements, time of starting and ending each irrigation, irrigation head, amount of water applied at each irrigation and during the season and crop report.

### Systems of Checking Land for Water Distribution

Two methods of checking land are in general use—the square- and strip-check systems. The square check is better adapted to areas having little slope and to the harder soils upon which it is necessary at times to let water stand one or two hours several inches deep in checks until the soil is saturated. Checks are ordinarily laid out so as to contain an acre and are either level or sloping slightly away from the box on the lateral. Borders or levees about 12 in. high and 10 or 12 ft. wide on the base surround each check. The land the levees occupy is not wasted, but is seeded and cropped exactly as the rest of the check; and while water seldom reaches the top of the levees, the soil subirrigates so that in looking over a well-laid-out and irrigated field of alfalfa the location of the levees is only distinguished by the apparently higher growth on them. The strip-check system is generally acknowledged the best method of laying out the land where the slope is sufficient. Checks 60 ft. wide and 300 ft. long, with a fall of 0.3 to 0.4 ft., give the best results. The old contour-check system is no longer used, and lands that were checked in that manner years ago are being rechecked to conform to one of the other systems that have supplanted it.

### Size of Irrigation Head

An irrigator is allowed the use of a 20-sec.-ft. head for 20 min. on each acre of land he irrigates. This amount spread evenly over his land would cover it to a depth of 6½ in. This head is turned into two or three checks at a time, and in the case of the ordinary sandy soil of the district is allowed to run into a check until it lacks 50 ft. or so of reaching the low end. It is then shut off and turned into another check. The application of too much water results in its piling up in the lower end of the check, and the water and hot sun kill the alfalfa.

While the time is usually strictly adhered to, the size of the irrigation head varies somewhat, and ditch tenders and the water distributor endeavor so to adjust the size of the head that the farmer will obtain 20 sec.-ft. at his field, and an amount equal to the transmission loss in the lateral (depending on its length) is added at the headgate.

During the season 66 irrigation heads were measured. The largest amounted to 40.9 sec.-ft. and the smallest to 10.50 sec.-ft. Only the largest ranches can use a head of more than 20 sec.-ft., and then it is divided into two heads. The average head in use on the 15 tracts during the season was 19.32 sec.-ft.

### Amount of Water Applied Per Irrigation

The amount of water applied to the land varied on different fields and at different times of the year. As a rule, the first irrigation was the heaviest. The late summer irrigations, however, usually took a large amount of water where it was available, not so much because the land required it, but because the farmers endeavored to "store" enough in the top soil to carry them through until the winter rains. Some fields were irrigated six times during the season, while others received water only three times. The average number of irrigations received by the 15 fields was 4.4. The lightest irrigation of the season was on a tract of young alfalfa and amounted to a depth of 0.25 ft. Water amounting to a depth of 1.55 ft. was used to irrigate another tract of older growth in a sandier location. The larger number of fields used a depth of 0.55 ft. or less for each irrigation, and the average amount of water applied at each irrigation on the entire number of tracts, was 0.65 acre-ft. per acre.

When raising alfalfa, irrigators prefer to irrigate a week or so before the hay is cut or just as soon as it is removed from the field. The average time between cuttings is about 32 days, and this represents the average period between irrigations for the season. In the harder soils, however, irrigation must be more frequent, and one field irrigated at 21-day intervals suffered severely for water between irrigations. On the other hand, where

*Irrigation Engineer, Lakeview, Ore.

the ground water was close to the surface and the crop subirrigated, fields went unirrigated 40 or 50 days without apparent damage to the crop.

The amount of water applied to the fields under observation during the season varied from a total depth of 1.55 ft. on a field of young alfalfa planted in a hard soil to a depth of 6.73 ft. on another field, perhaps the sandiest in the district. These two represent extremes. The larger number of fields used from 2.5 to 3 acre-ft. per acre in four or five irrigations. The average amount used on the 15 fields was 2.84 acre-ft. per acre.

### Irrigation Head and Volume per Irrigation

It is the general opinion of irrigators—which was substantiated by experiment and measurements—that a large irrigation head is more economical than a small one. One of the tracts under observation used 2.49 acre-ft. per acre during the season. This field was thoroughly irrigated each time and used heads of from 24.1 to 40.9 sec.-ft. Another irrigator who constantly utilized a head of from 10 to 12 sec.-ft. used over 6.50 acre-ft. per acre in six irrigations.

While a difference in soil of the two tracts was held responsible for some of this large difference, the larger part of it was charged to the small field laterals and boxes on the latter tract, which fed water into the checks so slowly that the upper ends were saturated to an unnecessary depth before water reached the lower ends. Measurements of depth of saturation in checks in this and other fields showed that the use of a small head invariably resulted in a much deeper saturation of the soil in the high end of the check than occurred in the low end. On the other hand, the larger head spread more rapidly over the check and resulted in a more even penetration of the water.

One of the best producing tracts in the district (partly subirrigated) cropped 8.50 tons of alfalfa between April and October. Other ranches were not so fortunate, and yields as low as 1.35 tons per acre were measured. Four to 6 tons per acre represented a general yield, and the average number of tons per acre cut from the tracts under observation was 5.4. This is believed to represent a fair average for the entire neighboring district and this part of the state.

### Transmission Losses in Canals and Laterals

The main supply canal which heads on Tuolumne River at La Grange is 44.7 mi. in length. Discharge measurements were made daily during the season on the upper 34.2 mi. The lower 10.5 mi. is classed as a main lateral, and the loss in the canal shown in the accompanying table is determined from the daily measurements mentioned on the upper portion of the canal. There are 96 mi. of main laterals in the district. These take water from the main canal at points below the twenty-second mile and are eight in number. The shortest is 7.3 mi. and the longest 17.1 mi. The capacity of these laterals runs from 2 to 10 irrigation heads. Measurements were made daily for seepage losses on 14 mi. of these laterals, and periodically during the season on the remainder. From all these measurements it was estimated that 16% of the water entering the main laterals is lost in transmission to the heads of the private laterals.

There are 1,600 mi. of private laterals in the district, mostly of one-head capacity. They are not continuously in use, nor are all in use at one time. The "run" in each is usually from one hour to several days during the month. The losses were determined as follows: When the system was working under normal conditions, ditch tenders reported the mileage of laterals in operation at a given time. In this way it was found that, as a rule, about 31.2 mi. of private laterals were in continuous operation during the season.

Numerous measurements were made on laterals of this type to determine seepage losses. It was found that the average loss per mile was 1.35 sec.-ft. The average length of a private lateral is 1.64 mi. It was estimated from this that 10% of the water taken into the heads of private laterals was lost in invisible seepage and evaporation between the farm and the head of the private laterals. The figures in the accompanying table correspond to this.

TRANSMISSION LOSSES IN CANALS AND LATERALS IN THE MODESTO IRRIGATION DISTRICT, SEASON OF 1914

| Month | Mean Flow of Intake Main Canal, Sec.-Ft. | Transmission Loss in Main Canal, Sec.-Ft. | Transmission Loss in Main Laterals, Sec.-Ft. | Transmission Loss in Private Laterals, Sec.-Ft. | Flow Reaching Fields, Sec.-Ft. | Per Cent. of Intake Capacity Reaching Fields |
|---|---|---|---|---|---|---|
| April..... | 416.9 | 96.9 | 51.2 | 26.9 | *161.9 | 38.8 |
| May..... | 629.5 | 101.8 | 84.5 | 46.3 | 396.9 | 63.0 |
| June..... | 670.6 | 121.6 | 87.8 | 46.1 | 415.1 | 61.9 |
| July..... | 583.2 | 113.0 | 75.2 | 39.5 | 355.5 | 61.0 |
| August... | 400.0 | 108.0 | 46.7 | 24.5 | 220.8 | 55.2 |
| Average | 540.0 | 108.3 | 69.1 | 36.6 | 310.0 | 57.4 |
| Per cent.. | 100.0 | 20.1 | 12.8 | 6.8 | 57.4 | |

* Estimated 80 sec.-ft. wasted on account of wet weather.

Operating losses are caused by (a) accidents to the main canal, which necessitate its being shut down for repairs; (b) losses due to changing the flow from one lateral or headgate to another; (c) accidents to laterals and leakage from structures. From careful records during the season it was estimated that operating losses for any year would be close to 5% of the intake flow of the main canal if it were in continuous operation during the season.

### Amount of Drainage from Irrigated Land

Six years ago a drainage canal extending from east to west through the district was built. Ground water stands at from 4 to 7 ft. below the surface of about 15,000 acres tributary to this canal. Although this land was irrigated with more than 2 acre-ft. per acre during the season, the flow of the drain averaged only 3 sec.-ft. during this time. It was estimated that less than 2% of the irrigation water reached the drain canal.

**A Minnesota State Park** with an unusual history is the Jay Cooke Park on the St. Louis River, 18 mi. northwest of Duluth. An area of 2,200 acres of wild land on the banks of the river has been given to the State of Minnesota for a public park by the heirs of Jay Cooke, the famous banker of Civil War times. The gift carries the stipulation that the state shall add 4,000 acres of adjoining land to the gift. At this point the St. Louis River is very turbulent, falling about 400 ft. in 5 mi., and the scenery is rugged and picturesque. The park is 7 mi. above the hydro-electric power plant of the Great Northern Power Co. The interesting history of this bit of country concerns the Duluth & Winnipeg Ry., an early northwestern project in which Jay Cooke was heavily interested. A roadbed had been graded through this section of the St. Louis valley, in spite of great physical obstacles, when the panic of 1873 caused the collapse of the project. Subsequently work was resumed and rails were laid on a portion of the work, when a disastrous accident led to its final abandonment. In the 40 yr. since, the roadbed has become overgrown with brush, but it is estimated that a few thousand dollars will convert the old railway right-of-way into a fine boulevard. There are trestles wanting across some ravines, but in these instances the boulevard will detour around on the hillsides.

# Valuation Discussed at Philadelphia

The "Valuation Conference" held at Philadelphia on Nov. 10, 11 and 12 under the auspices of the Utilities Bureau (the year-old intercity organization for joint support in utility cases) was a notable convention in point of attendance and flow of pertinent discussion. Three sessions a day were scheduled, and the attendance at each was about 150. Men representing municipalities and commissions from various parts of the country were present. There were a few utility men present, but by no means as many as had been invited. The papers of greatest engineering interest are briefly reviewed in the appended paragraphs. The whole proceedings will be made available by the Utilities Bureau in the January issue of its official organ, *Utilities Magazine*.

### Reproduction Basis of Worth Attacked

Lieutenant-Governor J. M. Eshleman of California, former president of the State Railroad Commission, presented the idea of "threat price"—the maximum at which a monopoly could induce a purchaser to buy, or the minimum that the public could force a company to make. Competition, it was held, acted to keep down the natural excess of threat price over cost. Reproduction cost (for present conditions) was a threat value which the utilities would establish as the limit on which the public would pay rather than build new. Fanciful and impossible assumptions about starting a business new under present conditions were held to be a serious bar to the use of reproduction cost of development ("going value"). Reproduction cost on historical grounds, it was admitted, was of value as secondary evidence of investment in the absence of original data.

H. F. French, attorney, of Baltimore, held up the true aim of valuation as the location of a middle ground between confiscation by the public or extortion by the utility. Reproduction-cost methods did not secure that medium and always worked in favor of utility. The reproduction method of appraising intangibles was ridiculed because of unreal assumptions necessary. The recent Supreme Court decision in the Des Moines gas case—where the 15% allowance for overhead items was allowed, but no addition was made for "going value"—was cited as ruling out reproduction estimates of intangible elements associated with physical plant.

Morris Knowles, consulting engineer, of Pittsburgh, held that the Des Moines case did not close the way for introduction of going value by reproduction-cost methods, since the court had only stated that the method of valuation in the case (by giving 15% overhead allowance) had duly included this element. He pointed to a danger in confusion of the terms "cost" and "value." There was a cost of reproduction which could be found and which might influence the final determination of value. He had found that the accounts of a utility never showed the entire investment of time, thought and interest, all of which, as the Wisconsin Commission had recognized, properly entered true cost. The reproduction method of estimating intangibles was a check on that element. The assailed assumptions about starting a new business, in his experience, had led to the actual reproduction costs which any company would have to stand if it were to repeat today what it had accomplished in earlier years.

In the paper on "How to Get Rid of the Reproduction-Cost Theory" G. W. Anderson, attorney, of Boston, formerly a member of the Massachusetts Public Service Commission, held that the investors should have a return only on what they furnished. The Massachusetts commission had ruled that investment honestly and prudently made was to be taken as the rate basis. Mr. Anderson urged that legislators should incorporate the investment basis in their codes.

In the discussion F. W. Stevens, Valuation Counsel, New York Central Lines, and former member of the Public Service Commission for the Second District, State of New York, claimed that the first introduction of the reproduction-cost theory was made by "the late Secretary of State" in the famous Smyth vs. Ames case. At that time it gave a value lower than the investment which the railroads had made; now it was attacked because it gave a value higher than the investment.

Frederic P. Stearns, consulting engineer, of Boston, approved of the introduction of investment as a basis for future plants and present extensions, but cited injustices which might result by its use against old companies. Equities could be maintained by using reproduction cost under historical conditions.

E. W. Bemis, Board of Supervising Engineers, Chicago, described how the general rise of land values in the United States had produced an unearned increment in railway real estate "of startling size." The capital charges on this increment, if distributed over rates, he believed would necessitate a serious increase.

### Appraisals; Short-Cut Valuation

C. L. Pillsbury, Chief Engineer of Valuation Bureau, District of Columbia, in the paper entitled "Making and Maintenance of Price Inventories," urged the standardization of inventories. The details of the inventory he would arrange in accordance with the purpose for which it was to be used; for instance, in a rate case he would value only property used and useful. He urged the continuance of inventories once established, the maintenance being done by the operating company with a permanent valuation staff under some outside direction and supervision.

Under the title "Valuation by Approximation" George G. Morse, Appraiser, Associated Factory Mutual Fire Insurance Companies, of Boston, described the inexpensive appraisals which are being made on insured factory property. His claim was that detailed appraisals were no more accurate because of the estimates for waste, contingencies, depreciation, length of life, etc. The insurance company's valuations were not dragged into court, although in two cases members of the appraisal staff had applied these methods outside and supported them in court. The manufacturing plant was first divided into buildings and machinery, the buildings being considered as empty structures. Everything which could be removed without altering the building was classed under machinery—including elevators, piping, wiring, etc. Machinery in turn was divided into machines, shafting, belting, piping, wiring, furniture and miscellaneous equipment. Unit-cost figures were based on replacing from today's markets.

Buildings were valued on the basis of square feet of floor area under normal conditions, and taking into account the effect of length, width and type of construction. All fixed machines were completely inventoried, but with

only such description as is necessary to determine the value—less than a dozen words if possible. By such a plan fixed machinery was listed in an incredibly short time. Standard machines were appraised from price lists, special machines by records or estimates.

The value of buildings and fixed machines usually amounted to more than half the total of a plant. Therefore it is inconsistent to spend a long time listing the minor items in detail. In this end certain "short-cut" methods have been devised. For shafting, an average price per linear foot was taken. Belt lengths were estimated by eye. For sprinklers and steam- and hot-water heating systems a few cents per square foot of floor area were allowed. Wiring was taken per light or per horsepower of motors. Furniture and apparatus were assumed to be a certain amount per main machine unit.

In arriving at depreciation 5 to 10% per annum was deducted. Buildings were held at a stationary value for a considerable time. Shafting was taken at 100%. In machinery only the parts which bore wear and tear were depreciated; an equilibrium value of 33% frequently resulted in machinery well maintained. Throughout the work a plant was considered as a going concern, with the machinery, no matter how antiquated, turning out salable products.

### Valuation of Lands Debated

"Principles Applied in Valuing Lands" was the title of a paper by Hammond V. Hayes, consulting engineer, of Boston. In presenting the appraisal of land for commissions or courts he would work out both an original cost and a reproduction estimate. Both of these were divided into two parts—the probable price which a company paid for land and the cost of condemnation, damages, purchase, etc. The direct-purchase element in both original-cost and reproduction estimates would be arrived at by the familiar sales-comparison method, taking in the one case transactions at the time of purchase and in the other case the present moment. The difference in the price actually or probably paid by the company and the normal market value at the time of purchase would reveal the excess cost borne by a utility. By further studies the trend of this ratio from early days might be established.

The discussion on land valuation was prolonged and largely dealt with law and economics. A. E. Helm, Counsel of the Kansas Public Utilities Commission, urged the use of land cost rather than appreciated value in rate basis. He held that the railways were agents of the public in maintaining highways and service and that therefore they had to hold in trust for the public any increment which their property acquired. J. M. Eshleman reported that the California Railroad Commission had seen danger in accepting the agency theory; it was possible to organize utilities in California today so that they became agents and escaped regulation. He believed that a "condition of servitude" existed which allowed different canons of valuation of public-utility property. For instance, in railway-condemnation cases the right-of-way had a smaller value than nearby land, because it was necessarily devoted to one specific purpose. Such an effect took away the unearned increments.

M. R. Maltbie revived a theory which he had proposed while a member of the New York Public Service Commission. He would admit the unearned increment of land, but each annual increment he would have entered in the annual income, offsetting in part the year's depreciation of plant or tending to lower the rates.

F. W. Stevens, Valuation Counsel of the New York Central Lines, reviewed the decisions of the Supreme Court, contending that the court had always interpreted value as being the economist's "market value." In spite of the apparent reasoning in a circle which sprung from the fact that this value depended on rates, he held that there was no escape from the dictum of the court until the law had been changed.

### The Place of Franchise Values

"Franchise Values" were discussed by Delos F. Wilcox, Deputy Commissioner, Department of Water Supply, Gas and Electricity, New York City. A franchise he held gives life to a physical property and must be valued on that basis. The appraiser, however, must not see double—must not duplicate his allowances by piling franchise value upon going value. For taxation, franchise value was not determined by either actual cost or reproduction estimates, the most widely accepted method being on net earnings over and above operating expenses, depreciation, taxes and a fair return on physical property. In rate cases it was held to be reasonably well settled in the courts that a separate and distinct value for a corporation's franchises at one cost need not be considered except where contract relations may require it. Where a separate franchise value may be introduced, based on actual cost, it is to be depreciated in proportion to its age where its life is limited. In condemnation proceedings cost or reproduction figures of a franchise are immaterial and present worth of its prospective earning power is the real criterion. Future rates enter as a doubtful element.

### Depreciation Discussions

"Court Decisions on Depreciation" was presented by J. H. Goetz, Counsel, Public Service Commission of the First District of New York. The importance of the present treatment of depreciation he illustrated by quoting recent statements made before the Interstate Commerce Commission that a deduction for depreciation from the value of railroads in the country would diminish their value by about $3,000,000,000. He held that the importance of distinguishing between the various purposes for which depreciation was considered had not yet been grasped. Regulating bodies were not confined to narrow questions but were concerned with the rights of investors and the development of enterprises.

Halford Erickson, in a paper entitled "Depreciation and Its Relation to Fair Value," outlined the necessity and the difficulties of measuring depreciation, citing the entrance of cost and salvage values and probable useful life. He argued for the establishment of actual depreciation reserves from which funds could be secured for making renewals of plants. He held that the sinking-fund method of providing additions to this reserve was the most efficient scheme. He held that the amount that the customers would have to pay to cover depreciation was actually less than with any repayment-of-capital method. He favored use of full value of plant in rate basis, except where the reserves provided by the customers had been paid out to the investors.

The concluding sessions of the conference were devoted to financial aspects of valuation, constitutional protection, opinion testimony and outlook for the future.

# News of the Engineering World

## Steel-Frame Building Burned

The steel frame of the wire shop at the John A. Roebling's Sons Co. plant, Trenton, N. J., was wrecked very thoroughly by the fire of Nov. 11. The picture herewith shows that brick walls and steel columns and beams did not contribute materially to making the building fire-resistant with respect to interior fire. While the walls offer a considerable degree of protection against exterior fire, the steel frame could not be of service in this respect and therefore is in no way superior to wood frame.

While the facts shown by the picture have long been known, they are interesting because they form the main basis for the development of the sprinklered "mill-construction system," with slow-burning main frame and reliance on fire-doors, sprinklers and alarms.

## A Local Engineering Society of Record Membership

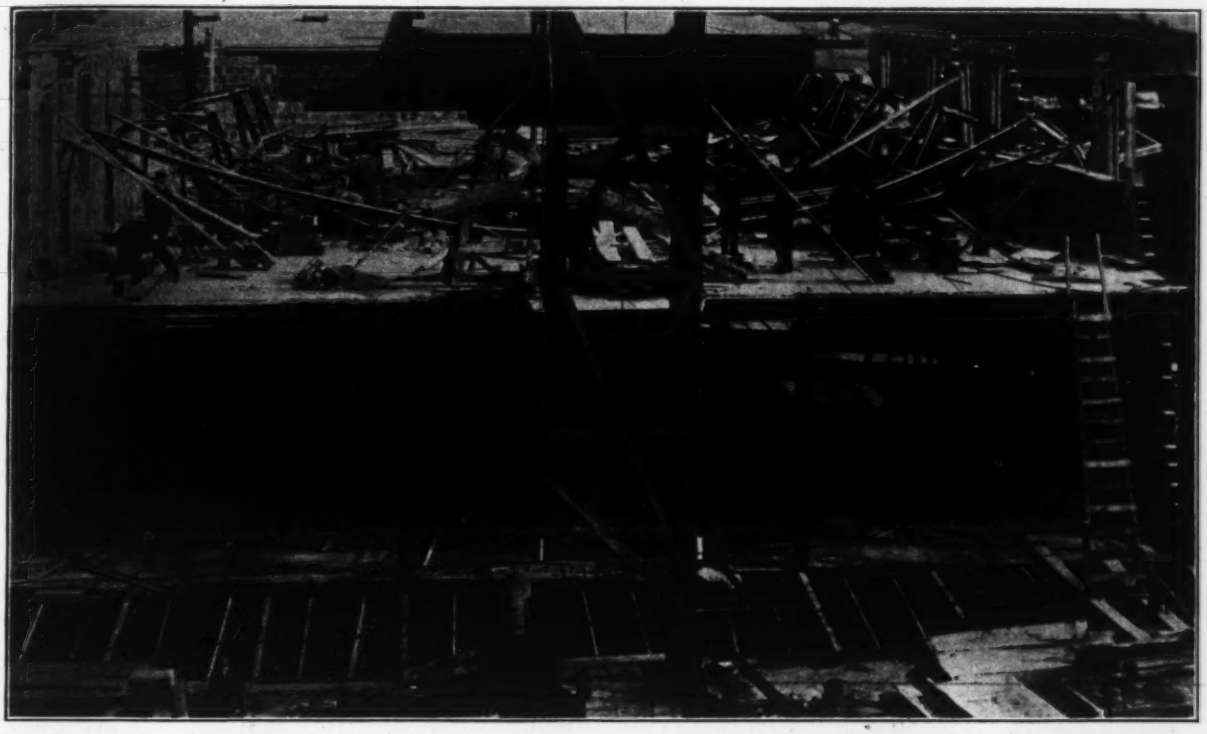
(CONTRIBUTED)

The result of the recent campaign of the Engineers' Club of Philadelphia is that the membership grew in five days from 551 to 2,127, far exceeding the most sanguine expectations. Briefly, the campaign organization consisted of a general chairman, a chairman in charge of the campaign teams, leaders of two divisions—each consisting of 13 teams—under so-called captaincies. These two divisions were pitted against each other in friendly rivalry for a handsome trophy in the form of a silver cup, on which the membership of the winning division was to be inscribed, and which was to be deposited at the club as a permanent memento of the occasion. In point of fact the activities of both divisions were so nearly balanced and the results so close—the winning division reporting 840 and the losing division 830—that the leader of the winners proposed, with the enthusiastic approval of all present, that the names of the members of both divisions should be inscribed on the trophy.

Contrary to expectations, the returns increased steadily day by day, numbering 670 on the last day. A careful revision of the returns shows that the application of the same individual has been reported in many instances in duplicate, and in a few cases in triplicate and quadruplicate by various teams, so that the reported total accessions of 1,670 represent in reality only 1,576 new members. A detailed analysis of the old and new membership is as follows:

| | Old Membership | Accessions | Present Membership |
|---|---|---|---|
| Honorary members | 4 | 0 | 4 |
| Active members, resident | 400 | 1,380 | 1,780 |
| Active members, nonresident | 123 | 94 | 217 |
| Junior members | 24 | 102 | 126 |
| Summary | 551 | 1,576 | 2,127 |

FIRE RUINS OF ROEBLING WIRE SHOP, SHOWING GENERAL WRECK OF STEEL FRAME WITH WOOD FLOORS



FRONT VIEW OF PIERCE BUILDING, OSWEGO, N. Y., WITH OVERTURNED ROOF-TRUSSES LYING ON SECOND FLOOR

Among the new members is Thomas A. Edison. No less than 200 applications were received after the campaign had closed, making the total 1,776.

The club was originally organized by a small group of leading engineers of this city in the fall of 1877, and some years ago acquired its own home in the club house which it now occupies. By increasing the membership above 1,500 a previously arranged sliding scale of dues goes into effect, which reduces the yearly dues of active members from $35 to $15, at the same time increasing the income of the club.

## Overturning Roof Truss Causes Collapse of Roof

The roof of a two-story building under construction in Oswego, N. Y., for H. D. Pierce fell on Oct. 22, 1915, while it was being concreted. One man was killed. The owner was superintending the work, having a few weeks before taken over the supervision from the architect, L. L. Cope. The plans had been approved by the city. According to the best evidence now at hand, the roof would have been sufficiently strong if the trusses had been fully braced during construction. The trusses turned over, twisting the columns with them. They had been guyed to hold them in place until completion of the roof, but it is reported that some time before the accident one of the guy wires was removed.

The building is 66x100 ft. in plan and comprises steel framework, 8-in. hollow-tile walls and concrete floors and roof. The roof was carried by trusses 16 ft. 5 in. apart. At the time of the collapse a panel of roof concrete was being placed. It is thought that the collapse was due to lack of bracing of the steel roof framing. A brisk west wind (20 to 25 mi. per hr.) was blowing at the time of the accident, and this may have helped start the collapse, as the roof fell toward the east, or rear, of the building.

The second floor of the building, on which the wreckage fell, seems to have remained uninjured. The walls were damaged only where the columns were wrenched out of place when the trusses fell.

## A Big Railway Peak Load

The peaks of traffic on the New York, New Haven & Hartford R.R. due to the Yale football games at New Haven and to the Thanksgiving recess in New England colleges and female seminaries have long been notable. But the record of Nov. 13, the day of the Yale-Princeton game, establishes a new high-water mark in this tide of travel. In 4 hr. 20,232 passengers were unloaded at New Haven—13,277 from New York and 6,955 from Boston and other points. They came in 22 regular and 23 special trains. When the tide turned, 19,678 passengers were carried out of New Haven between 5 and 7 p.m.—in 22 regular and 20 special trains.

There were no mishaps; 32 trains were on time, 14 arrived ahead of schedule and the rest were only a few minutes late. All New York traffic was handled by electric traction. The operating and traffic departments of the company had been at work for weeks perfecting the plans and devising safeguards against mishaps. A 20-page pamphlet was issued as a guide for the employees; special telephones were installed at various points in yards and terminals to facilitate the movement of trains; officers of the traffic, operating, engineering and mechanical departments were stationed at different points

on the route to look after matters pertaining to their respective departments in case their help was needed. The crowd was extremely well ordered, which helped to make the work considerably easier and more pleasant.

## Bugs Bore into Leaded Cables

EDITORIAL CORRESPONDENCE

A widely published press dispatch recently announced the discovery by Albert Schuler, of Santa Barbara, Calif., of a bug which eats lead. At a recent meeting of telephone engineers at San Francisco, Mr. Schuler, who is manager of the Home Telephone System of Santa Barbara, reported the discovery of this strange bug and gave an account of its depredations, which in the newspapers was reported to be the real cause of so-called electrolysis.

Probably most engineers who read the newpaper story at once placed it in the same class with the famous and far-traveled hoax about "the worm that eats steel rails" which was perpetrated a quarter of a century ago and still reappears at intervals.

One of the editors of *Engineering News,* however, has since visited Santa Barbara and has seen the bugs, a number of which are held in captivity in lead boxes with glass covers, to see how long it will take them to bore their way to freedom. The bug is a slender black beetle, with hard wing covers, about ¼ in. long and of innocent and placid demeanor. Perhaps the reported alias of the marauder should be placed on record to aid in the detection of other members of the guild—*Sinoxylon declive.*

PLUMBI TEREBRA CALIFORNIENSIS
Alias Sinoxylon declive

It is stated that what the bug does is to light on a lead-covered telephone cable and bore a tiny round hole through the lead sheath and the paper insulation down to the copper. Possibly he (the bug) believes the cable to be part of a tree or vine into which he is accustomed to bore holes, and so he proceeds to bore through the lead as he would through the bark. One entomologist gives concealment as the motive. Any engineer familiar with the rate at which the *Teredo novalis* can drive his boring apparatus through hard wood will see nothing impossible in a beetle boring into a lead cable covering.

The accompanying view is reproduced from the only photograph the bug has ever had taken, and indicates, not very clearly, the two scoops on the prow with which he bores. Why the bug should want to bore holes is as yet an unexplained mystery, as it seems wellnigh impossible that he could derive a high degree of nutrition from the lead, even if it did not make him sick. It is possible, however, that the boring process is preliminary to egg depositing, in which case the foregoing account is all wrong as to the bug's sex and apologies are due to her.

The lead borer has been heard of in South Bend, Ind., Rockford, Ill., in Omaha, Tacoma, Portland, San Diego, in Florida and far away Australia. Numbers of them have been found in old lead foil of tea packages and it is suspected that the family is of Oriental extraction. Quarantine is being considered to check the menace.

**Two Warehouses Were Burned** on Pier 34, Baltimore & Ohio R.R., Baltimore, Md., Oct. 28. The loss is estimated at $400,000. The cause of the fire is unknown.

**A Collision on the Central R.R. of New Jersey** on Nov. 9 between two freight trains caused the death of two trainmen and injuries to four others. One train was stalled on a heavy grade about 3 mi. from Newark, N. J., and in backing down collided with an upbound train.

**A Fire in the Bethlehem Steel Co.'s Plant** at South Bethlehem, Penn., on Nov. 10 destroyed one of its machine shops. The loss is estimated at about $1,500,000. The building was of so-called fireproof construction with brick walls and a steel floor system. The cause of the fire was said by the company to have been a short circuit, which ignited a small quantity of oil in a part of the building used to manufacture field guns.

**The Geology of the Hetch Hetchy Aqueduct** district in the Sierra Nevada Mountains will be determined by L. W. Stocker, who has been assigned by the United States Geological Survey to carry out that task in coöperation with M. M. O'Shaughnessy, City Engineer of San Francisco.

**Unnecessary Air-Duct Menaces Safety of Tunnel**—The Boston Transit Commission is removing the ventilation duct from the East Boston Tunnel. The only statement which has been made on the matter is that "the air duct is unnecessary and its removal will, in the opinion of the engineers, increase the safety of the tunnel."

**Lightning Rods Protect Ohio Buildings**—State Fire Marshal B. Buckley has reported that no buildings in the State of Ohio protected by lightning rods were fired by lightning during the past summer-storm season (three months ending Sept. 1). But there were 68 fires from lightning on unrodded buildings, causing a loss of $91,163.

**A Motor-Bus Feeder Service** for the municipal railway line of Portland, Ore., has been inaugurated. The City Council recently approved a contract with one F. M. Peterson for the operation of motor buses between 13th Ave. West and Nickerson St. and Ballard Ave. and Market St. The contractor receives 3c. for each adult carried and 1.5c. for each school pupil. The city will receive 2c. and 1c. respectively. The contractor is required to furnish an indemnity bond and has the right to extend his route to 20th Ave. and West 65th St.

**An Engineer Arbitrator Will Be Selected** from a list of 15 engineers of national reputation to arbitrate on the value of the physical property of the Spring Valley Water Co. in the rate cases pending in the Federal Court. The names will be selected by M. M. O'Shaughnessy, City Engineer of San Francisco, and the choice will be made from them by the city and the company. It is expected that this procedure will save large sums of money that would have to be paid for expert witnesses on the two sides had testimony been taken before a master in chancery.

**The Dredging in Boston Harbor,** referred to in the article in "Engineering News" of last week, page 956, amounting to 1,500,000 cu.yd., is now ready for contract letting. Proposals for the work will be received on Nov. 24. Prices for dipper dredging in Boston harbor have recently been as low as 11⅛c. per cu.yd., and offers of 2c. per cu.yd. for depositing the material within the harbor limits have been made by several dredging companies. Robert E. Barrett is acting chief engineer for the Directors of the Port of Boston. The time limit for receiving bids is Nov. 24.

**Sewage-Treatment Works for Lexington, Ky.,** were authorized by a 4 to 1 popular vote on Nov. 2, which approved a $300,000 bond issue for that purpose. At the same time $50,000 of storm-sewer bonds were authorized. It is expected that construction will be started right away, in accordance with a scheme outlined by the Solomon-Norcross Co., consulting engineers, Atlanta, Ga., in a report to the City Commission of Lexington dated Oct. 9, 1915. The scheme includes coarse screens, grit chambers, two-story settling tanks, sludge beds, sprinkling filters and a laboratory. The estimated cost of outfall sewers and a disposal plant to treat 3,000,000 gal. of sewage a day is $270,000, plus $30,000 for land, legal and engineering expenses.

**Plans for Straightening Turkey Creek,** Kansas City, Kan., are taking definite shape. The proposed channel will be approximately 1,700 ft. long, consisting largely of vertical retaining walls 66 ft. apart at the top in the widest point of the channel. The channel is designed to carry about 25,000 sec.-ft.—a flow somewhat greater than that of the flood of Sept. 7, 1904, which was the largest on record. In some places the bottom as well as the sides of the channel will be con-

crete lined, making it practically a flume. The estimated cost of the project is between $300,000 and $700,000. The proposed work has been approved by the City of Rosedale, the City Council and the Mayor of Kansas City, and all that remains to be done before starting construction is to obtain court condemnation proceedings.

## PERSONALS

Mr. Edward S. Larned has resigned as New England States Manager of Sales of the Lehigh Portland Cement Co., of Allentown, Penn.

Mr. Walter N. Polakov, M. Am. Soc. M. E., has resigned as Superintendent of Power Plants of the New York, New Haven & Hartford R.R. to engage in private practice.

Mr. Thomas W. Connette, Assistant Superintendent of Transportation of the Buffalo (N. Y.) city lines of the International Ry., has been made Superintendent of Transportation.

Mr. P. H. Anthony, of the C. D. Cooley Co., architects and engineers, of Pittsburgh, Penn., is now located at the company's newly opened Western office in the Waldheim Building, Kansas City, Mo. He will devote his time especially to the territory west of the Mississippi River.

Col. Herbert Deakyne, Corps of Engineers, U. S. A., who for the past four years has been in charge of the Missouri River improvement work between the mouth of the river and Sioux City, has been relieved from duty. Col. James F. MacIndoe, who has been located in the Philippine Islands, will succeed him.

Dr. S. S. Goldwater has resigned as Commissioner of Health of the City of New York and will resume the superintendency of Mt. Sinai Hospital, in that city. Dr. Haven Emerson, Deputy Commissioner and Sanitary Superintendent of Health, will succeed Dr. S. S. Goldwater as Commissioner of Health of the City of New York.

Mr. Frank R. Judd, Assoc. M. Am. Soc. C. E., formerly Chief Draftsman of the bridge and building department of the Illinois Central R.R., has been appointed Engineer of Buildings of that road. He was born in Hamilton, Ont., in 1882. Mr. Judd attended the Chicago Manual Traing School for three years and immediately afterward, in 1899, entered the service of the Illinois Central as a draftsman.

Mr. Henry U. Mudge, formerly President of the Chicago, Rock Island & Pacific Ry., has been elected President of the Denver & Rio Grande R.R., with headquarters in Denver, Colo. He succeeds Mr. Arthur Coppell, of New York City, who has been serving temporarily as President. Mr. Mudge was born in 1856 at Minden, Mich. He entered the service of the Atchison, Topeka & Santa Fé Ry. at the age of 16 as a water boy, and had risen to the position of General Manager when he left that road in 1905 to become Second Vice-President of the Chicago, Rock Island & Pacific. Mr. Mudge has been President of the American Railway Association during the past year.

## OBITUARY

William J. Smith, one of the promoters of the first cable-car line in Kansas City, Mo., died at his home in that city on Nov. 8, at 79 years of age. Mr. Smith was born in New York City and was educated at the Irving Institute, Tarrytown, N. Y.

Wirt du Vivier Tassin, formerly Chief Chemist and Assistant Curator of the Division of Mineralogy of the United States National Museum, died in Washington, D. C., on Nov. 2, at the age of 46. He was born in Fort Whipple, Va., and was a graduate of Cornell and Harvard universities. He was special agent of the United States Geological Survey at the World's Fair at Chicago, and in 1893 received his appointment at the Museum, where he remained until 1909. Since then Mr. Tassin had engaged in private practice as a consulting metallurgist and chemical engineer.

James F. DeVoy, Assistant Superintendent of Motive Power of the Chicago, Milwaukee & St. Paul Ry., died at his home in Milwaukee, Wis., on Nov. 5. He was born in Ithaca, N. Y., in 1866, and was graduated from Cornell University as an honor student in mechanical engineering. For seven years following his graduation Mr. DeVoy was employed in the mechanical department of the New York Central & Hudson River R.R., and afterward by the American Locomotive Co. He had been in the service of the Chicago, Milwaukee & St. Paul Ry. for the past 15 years. At the time of his death he was a member of the executive committee of the American Railway Master Mechanics' Association and past president of the Western Railway Club.

William Frederick Allen, Assoc. M. Am. Soc. C. E., General Secretary of the American Railway Association and Editor and Manager of the "Official Railway Guide," died on Nov. 9 from a stroke of apoplexy, at his home in South Orange, N. J. He was born at Bordentown, N. J., in 1846 and received his education at the Protestant Episcopal Academy and the Bordentown Model School. He was first employed as a surveyor on the old Camden & Amboy (N. J.) R.R. In 1868 he became Engineer of the West Jersey R.R. Mr. Allen was an expert on the standardizing of railroad time. In 1875 he was made General Secretary and Treasurer of the General Time Convention, which was composed of the principal trunk-line railways and was represented by their general managers and superintendents. The following year he was elected Secretary of the Southern Time Convention, consisting of the leading Southern railway lines. These conventions were consolidated in 1886 and from them the American Railway Association developed.

## ENGINEERING SOCIETIES

COMING MEETINGS

THIRD ANNUAL PENNSYLVANIA WELFARE AND EFFICIENCY CONFERENCE.
Nov. 16-19. Conference in Philadelphia.

NATIONAL MUNICIPAL LEAGUE.
Nov. 17-19. Annual convention, Dayton, Ohio. Secretary, Clinton Rogers Woodruff, 705 North American Building, Philadelphia.

OHIO SOCIETY OF MECHANICAL, ELECTRICAL AND STEAM ENGINEERS.
Nov. 18-19. Annual meeting at Zanesville, Ohio. Secretary, F. E. Sanborn, Columbus, Ohio.

AMERICAN INSTITUTE OF ARCHITECTS.
Dec. 1-3. Annual convention in Washington, D. C. Executive Secretary, E. C. Kempe, The Octagon, Washington.

AMERICAN ASSOCIATION OF ENGINEERS.
Dec. 10 and 11. Convention in Chicago. Secretary, Arthur Kneisel, 29 South La Salle St., Chicago.

ASSOCIATION OF AMERICAN PORTLAND CEMENT MANUFACTURERS.
Dec. 13-15. Annual meeting in New York. Secretary, Percy H. Wilson, Bellevue Court Bldg., Philadelphia, Penn.

SECOND PAN-AMERICAN SCIENTIFIC CONGRESS.
Dec. 27-Jan. 8. Washington, D. C.

**Montana Institute of Municipal Engineers**—The annual meeting will be held in Billings, Mont., Jan. 17-19, 1916. The president is C. E. Durland, of Billings, and the secretary is Carl C. Widener, of Bozeman.

**National Lime Manufacturers' Association**—The annual meeting will be held in Cleveland, Ohio, the first week in February, 1916. Fred K. Irvine, 537 South Dearborn St., Chicago, is secretary.

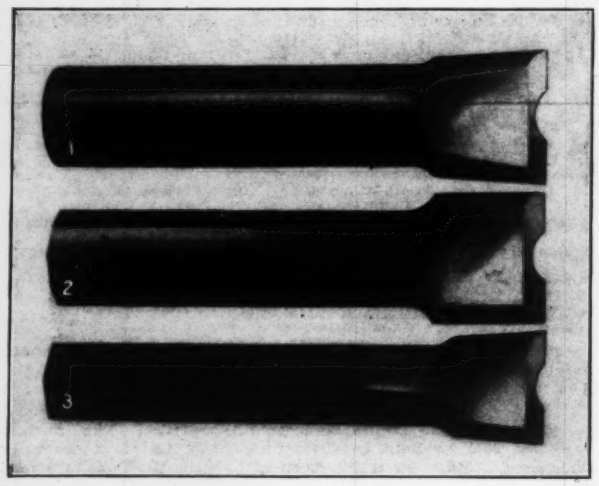
**International Road Congress**—Although the title of this road meeting is rather misleading, there is every evidence that the congress to be held in Worcester, Mass, Dec. 14-17, will be the largest affair of its kind ever held in New England, and it will be primarily a meeting of New England highway officials. The president of the congress is Hon. J. Lewis Ellsworth, former Secretary of the Massachusetts State Board of Agriculture, and the advisory board includes the following: George W. Tillson, Consulting Engineer of Brooklyn, N. Y.; W. A. McLean, Chief Engineer of Highways and Commissioner of Ontario Public Roads and Highways, Toronto, Ont.; Irving W. Patterson, Chief Engineer, Rhode Island State Board of Public Roads; Frederic E. Everett, State Engineer of New Hampshire; Charles J. Bennett, State Highway Commissioner of Connecticut; Stoddard B. Bates, State Highway Commissioner of Vermont; William D. Sohier, Chairman of the Massachusetts State Highway Commission; Philip J. Deering, Chairman of the Maine State Highway Commission, and Frederick H. Clark, President of the Massachusetts Highway Association. The Program Committee is composed of Harold Parker, former Chairman of the Massachusetts Highway Commission, now President of the Hassam Paving Co., of Worcester; E. L. Powers, Editor of "Good Roads," New York; A. W. Dean, Chief Engineer, Massachusetts Highway Commission, and John H. Brownell, Chairman of the Convention Committee of the Worcester Chamber of Commerce, under whose auspices the congress is to be held. There is to be a governors' day, when the Hon. David I. Walsh, Governor of Massachusetts, will preside; a roadbuilders' day under the auspices of the Massachusetts Highway Association, a mayors' day, when Mayor Wright of Worcester will preside, and an auto-

mobile day, when automobile manufacturers will be heard. There will be an exhibition of road machinery. The headquarters of the congress will be at the Bancroft Hotel and the exhibition will be held in an adjoining auditorium.

## Appliances and Materials

### An Improvement in Drill Bits

An improved type of drill bit, known as the "Carr bit," is being made by the Ingersoll-Rand Co., 11 Broadway, New York City. Three forms are shown in the accompanying views. This bit, while designed primarily for overcoming certain difficulties in drilling rock, has been found to meet satisfactorily not only these special conditions, but the ordinary conditions as well. The Carr bit has but a single cutting edge and is uniform and symmetrical in shape. A transverse recess is formed across the center of the bit. With hollow steel this recess is tapered until it runs into the original hole through the steel; with solid steel the recess extends back about ½ in. from the face. This recess tends to act as a pilot and reduces the cutting or contact surface with the rock to a minimum. The thickness of the bit is made equal to the short diameter of the steel and the length equal to the bit gage. Hollow drill-steel bits are conical in shape and have a 5° taper on a side. Solid steels have straight parallel cylindrical sides. The advantages claimed for this bit are many. It holds its gage better, thereby increasing the depth to which




CARR BITS FOR ROCK DRILLING

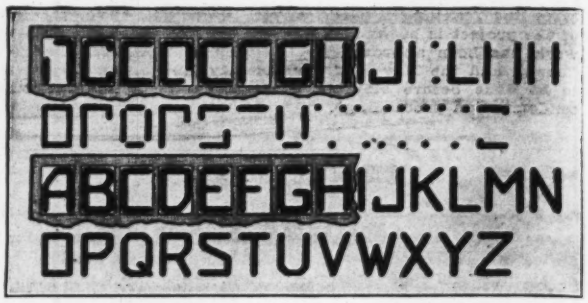
1—For Leyner water type. 2—For piston drill. 3—For large sizes of automatic hand drills

a hole may be drilled with a single steel. It drills a round hole and therefore rotates easily. It does not require more than $\frac{1}{16}$-in. variation in the gage of bits on successive lengths of steel. The bit, being simple in form, is easily made. The idea of drilling a hole the same size from the collar down to the bottom originated with the inventor from a discovery that a drill bit cuts a margin of clearance for itself; and to insure the drilling of a round hole, the shape of the bit was made such that it would be impossible for it to go down if the hole were not round. The loss of gage was overcome by providing the long shoulders curved concentric with the axis of the bit. Rapid cutting speed was assured by forming the transverse recess in the center of the bit, reducing the area of contact.

* * *

### Lettering Templets for Draftsmen

Lettering templets of transparent celluloid are now a regular product of the Keuffel & Esser Co., New York City. What is known as the "Simplex" templet consists of a strip with two rows of different-sized perforations uniformly spaced. This is placed on a cardboard guide, which raises the half of the templet in use away from the drawing and thus prevents blotting. A pencil or a special hollow glass pen, held perpendicularly, is used for lettering. Lines which do not conform to edges of the templet, such as the oblique and cross lines in K R and A, are drawn in freehand without shifting the templet. The first perforation at the left of the templet is wider than the others, so that it can be used for



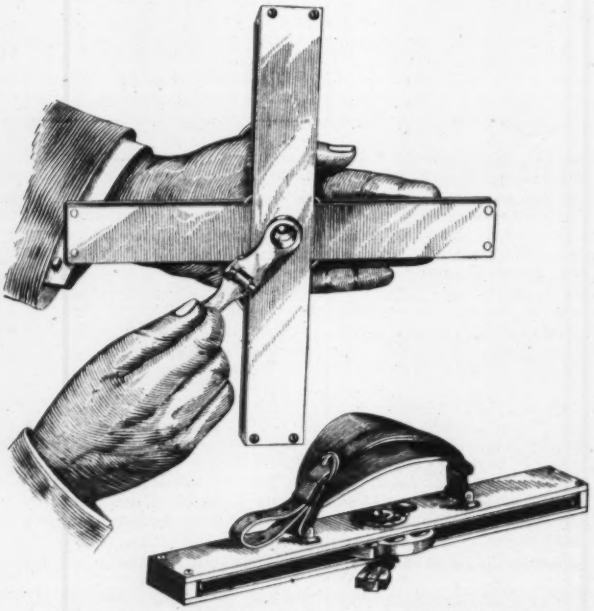

TRANSPARENT LETTERING TEMPLET FOR DRAFTSMEN

such leters as M and W. The sketch shows the different steps in using the templet. The templets come in sets of two, three and five, for both vertical and slanting letters. List prices range from $1.25 to $4 per set.

* * *

### Folding Reel for Steel Tapes

A four-arm reel for steel tapes made of nickel-plated steel and so constructed that it may be folded and carried in the pocket, is a recent addition to surveyors' equipment of the Keuffel & Esser Co., New York. This reel is especially



FOUR-ARM FOLDING REEL FOR STEEL TAPES

designed for tapes of over 100 ft., which ordinarily are not carried on reels, and is made in three sizes for tapes ¼ in. wide, 100 to 500 ft. long. Hitherto most folding reels have been of the three-arm type. The list price is $3.40 each.

* * *

### Drilled-Letter Highway Sings

Highway direction or warning signs and street-name signs made of heavy "pure-iron" sheets, with the letters or figures drilled about ⅛ in. into the metal, are being manufactured by the Indestructible Sign Co., Columbus, Ohio.

HIGHWAY OR STREET SIGN WITH DRILLED LETTERS

The drilling takes the place of etching and, giving a sharper, cleaner edge, is claimed to make a more durable sign. The method of manufacture is patented. Any material—iron, steel, wood, brass or copper—may be used in the same way.

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# Goethals on Panama Slides

## Report of George W. Goethals, Governor of the Panama Canal, to the Secretary of War; with Selected Illustrations

*SYNOPSIS—Present great slides on east and west banks at Culebra involve about ten million cubic yards, of which a million yards per month is being dredged out. Dredging is the only feasible method of attack. Prior slides at other points, including the Cucaracha slide, are discussed. Report written under date Oct. 26, 1915, at Balboa Heights, Canal Zone.*

The following report is submitted on the slides which have closed the Panama Canal to navigation. On account of the importance of the subject, I deem it advisable to make a comprehensive report, even at the expense of repetition of the matter contained in previous documents on the subject.

The slides which developed during the construction period were of three distinct types. The first were due to the moving of material from the sides of the prism or cutting, when these were left by the excavation at a steeper slope than that at which the material would remain at rest.

In those of the second type porous material mixed with clay, small rock and spalls, overlay smooth surfaces of rock or other impermeable substances, harder than the overlying mass, which sloped toward the axis of the canal. In excavating the prism through these sections, the removal of the lateral support, combined with the effects of the water permeating through to the underlying inclined strata, resulted in the sliding of the material into the excavated area, the rains assisting and accelerating the movement.

FIG. 1. VIEW NORTH BETWEEN CONTRACTORS HILL (LEFT) AND GOLD HILL (RIGHT) SHOWING CULEBRA REGION

Small slides on both banks caused by admission of water to canal. The great slides came later